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VOLUME 3, No. 2 FEBRUARY 1951

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WORLD CROPS

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Published monthly by Leonard Hill Limited, 17 Stratford Place, London, W.1, England. (*Tel. Mayfair* 7383)
U.S.A. 17E 48th Street, New York City (*PLaza* 5-1127)

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Editorial Comment

The Colombo Plan

FEW documents have received more attention in the public Press recently than the Colombo Plan for Co-operative Economic Development in South-East Asia, presented to Parliament last November. It would probably have received even more had not the overwhelming anxieties of the international situation perforce bulked so largely in the public view, for South-East Asia, after Europe itself, is probably the most important key area in deciding the future of the human race. Its teeming populations—roughly a quarter of the whole population of the globe is concentrated there—their low standard of living, the fact that it is the most important source of many vital staples, the present low rates of production per head and the vast potentialities for further increased production all combine to make its problems of vital urgency. If they are not tackled efficiently in the near future, the upsurge of popular feeling engendered by the hardships of the war and sedulously fostered by unscrupulous Communist propaganda may well give rise to a convulsion, the effects of which cannot be overcome within a foreseeable period.

The report only deals specifically with territories within the British Commonwealth, but the problems are identical in other non-Commonwealth countries in the region, and it is a good sign that, apart from representatives of the Commonwealth territories, observers from Burma, Viet Nam, Laos, Cambodia and Indonesia were present.

It contains a comprehensive survey of the position in India, Pakistan, Ceylon, Malaya and the territories of North Borneo, Brunei and Sarawak, with six-year development programmes for each. The total cost of these is estimated at £1,868,000,000, of which £248,000,000 could be found from sterling balances, the remainder having to be derived from other sources such as governments inside and outside the Commonwealth, the International Bank and private investment.

The plan does not say how this finance is to be obtained; it merely shows what the countries can do to improve their economies and indicates the extent of the help needed to achieve this. Nor does it claim that the programmes if carried out would greatly raise the standard of living; on the contrary it states that they would hardly do more than maintain the present standards, being given the rapid rates at which populations are growing in these regions. It is to be hoped that this may be a somewhat over-cautious estimate and, in any event, one can agree strongly with the view that the programmes would fortify the economy of the whole area and provide a sound basis for further improvement in the future. In the allocation of finance under the programmes India with its vast area and population of 350,000,000 naturally has the largest share with £1,379,000,000; Pakistan with a population of 85,000,000 follows with £380,000,000, while Ceylon and Malaya-Borneo with populations of approximately 7,000,000 each get respectively £103,000,000 and £107,000,000.

Place of agriculture in the plan

As the area is predominantly dependent on agriculture and as, moreover, much of the agriculture is still primitive and yields low, it is natural that it should bulk predominantly in the programmes. Thus, on a percentage basis for the whole area, 32% of the total expenditure envisaged as necessary is allocated to agricultural improvement, while 34% goes to transport and communications, a natural corollary, since development is largely bound up with improvements in the latter regard. The remainder is allocated between fuel and power (6%), industry and mining (10%) and capital for social improvement (18%).

In regard to agriculture the chief emphasis is naturally on increased food production coupled with increased production and greater diversification of cash crops. The main directions in which development is envisaged are the extension and improvement of irrigation facilities, reclamation and development of areas at present uncultivated owing to lack of drainage and other causes, introduction of modern methods and mechanical equipment, increased use of fertilisers, and so forth. The accomplishment of the plan must involve the recruitment of considerable additional technical staff, and the difficulties in obtaining this are reviewed in a separate chapter, in which the establishment of a Commonwealth Council for Technical Co-operation is advocated as one means of helping to meet this need.

Some reflections

The plan as a whole is a courageous and realistic attempt to deal with the problem as it presents itself in the Commonwealth territories. But its fulfilment is contingent upon similar measures being taken in the adjacent non-Commonwealth territories. This is indeed well recognised in the report, and the fact that representatives of these other countries were present as observers seems to indicate an earnest desire to co-operate. As for the programmes themselves, a point that seems to call for comment is that, comparing the programmes

for Ceylon and Malaya-Borneo, although the populations of the two are about the same and the total amounts suggested as necessary are practically identical, £102,000,000 in the case of the former and £107,000,000 in the latter, the percentage to be expended on agricultural development in Malaya (12.1%) is far smaller than that proposed in Ceylon (37%). The agricultural conditions in both territories are similar in some respects; both are markedly dependent on imported food and both rely considerably on the cultivation of cash crops, notably rubber, tea and coconut products for export. But the Malay-Borneo region has far greater possibilities for agricultural expansion than has Ceylon, if only by reason of its size. The potential area in Ceylon available for further agricultural development is estimated to be about 3,000,000 acres, while that in Malaya and Borneo is many times this area, much of which is still entirely undeveloped and its potentialities unknown.

Unlike the other regions of the scheme, 49.5% of the total expenditure is to be allocated to capital expenditure on social services, as against 11 to 27% in the other three territories, and of this the enormous sum of £35,600,000 or approximately 33% of the total is to be expended on social services on Singapore Island.

It is argued that this expenditure is urgently necessary as a constructive measure to combat terrorist influence, but surely this is a doubtfully valid argument, since the expenditure is apparently fundamentally dictated by political and security considerations and not by its relationship to economic considerations at all, which are the basis of the plan. After all, Singapore is essentially the chief port of Malaya; its prosperity and indeed its existence are largely dependent on productivity in the Malayan Federation, and to separate the two and allocate 33% of the total expenditure envisaged for the whole area to social betterment in that small though densely populated island (its total area is only 200 square miles) and only 12% to the improvement of agriculture throughout the whole vast region of about 130,000 square miles would seem to argue some lack of proportion in the minds of those responsible for framing the Malayan part of the plan.

Agricultural advisory services

IT is at last well recognised that putting over the results of research to the practising farmer is every bit as important as the actual performance of the research itself. Out of this recognition has grown the advisory or, as they are often termed, the extension services which now form an integral part of the official provision for assisting agriculture in most countries.

More tardily has come the recognition that the manner in which this is to be done is highly important and that a successful advisory service should have its own techniques, which may have to be varied with the circumstances and the character of the cultivator in any particular region; for example, the approach to, say, a fruit farmer in Kent may differ markedly from that required in the case of a cultivator in Central Europe, a truck farmer in the Middle West of the U.S.A. or a grain producer on the Canadian prairies, while these again might be quite inappropriate to primitive native cultivators in Africa or to the somewhat more developed smallholders of the Far East.

Accordingly the recently published report of the working party which recently visited 14 European countries to study agricultural advisory services in action, under the auspices of the Organisation for European Economic Co-operation, is of more than passing interest.

The countries visited were Austria, Belgium and Luxembourg, Denmark, France, Germany, Greece, Eire, Italy, Holland, Norway, Portugal, Sweden, Switzerland and Britain.

It would be invidious to draw comparisons between the various national services. Each European country has had distinctive post-war recovery problems to face and basic national conditions have not been reasonably comparable.

Advisory workers are mostly pre-trained at universities and agricultural colleges; these higher educational centres should periodically review their courses to ensure that they are fully adapted to the changing needs of modern agriculture. Full weight should also be given to training in agricultural practice. Nevertheless, pre-training is not enough. The new adviser should be given initial training in the technique of 'advising'—approach to the farmer, public speaking, etc. There should also be occasional refresher courses for all advisers so that the service as a whole makes the fullest use of modern advances in instructional methods and techniques.

It is essential that advisers should be adequately paid and provided with proper equipment, offices and transport facilities. In the words of the report itself: 'Neither the down-at-heel doctor nor the down-at-heel adviser is wanted in the rural community.' A feature in all countries is the need for closer contact between advisers and agricultural research workers. There should be regular lines of co-operation and periodic discussion meetings. Another fairly general suggestion is that demonstration farms and plots should feature more widely in the work of advisory services. Far too many advisers have numerous administrative duties to perform; not only do these reduce the time available for advisory work but they may also lessen the farmer's willingness to make use of the service.

Routine work such as sampling soils, fertilisers

and feeding-stuffs should be delegated to technicians and not performed by advisory officers, while much more emphasis should be placed upon farm economics and farm management. At present advice on these important aspects of farming cannot be provided in some countries. In others it is left in the hands of the universities or other education organisations.

The report should be read by every agricultural adviser, while the information and views contained in it are a valuable contribution to the literature of this essential.

Tractors and tools in the tropics

IN our last issue we published some interesting correspondence on the subject of the possibilities of mechanising peasant agriculture in the tropics, as a sequel to an article on the same subject by Mr. J. E. Mayne in our November issue. In settled and highly developed countries like Great Britain or the U.S.A. the expansion of mechanisation on both large and small farms has brought great benefits in its train and, although some still believe that the tractive animal still has a part, albeit a much restricted one, to play in farming for some time to come, none will gainsay that the revolution brought about by the tractor has enormously increased farming efficiency and that in due course its triumphs will be even greater. A glance round the recent Smithfield Show amply demonstrated this and gave indications of what may be anticipated.

In the tropics, however, the case is somewhat different. It is true that on the large and medium-sized estate there is plenty of scope for mechanisation and that in many tropical and sub-tropical countries mechanisation is making great strides and will no doubt make even greater ones in the future; yet on the widely scattered, remote and oft-times very small holdings of the tropical peasant cultivator the case is very different and those who envisage the rapid mechanisation of tropical peasant cultivation are deluding themselves with wishful thinking and taking insufficient account of the inherent difficulties.

The recent publication by the Stationery Office of a report to the Colonial Advisory Council on Agriculture emphasises these difficulties. It is not our intention to review this report here—a summary of it will appear in our next issue—but we would commend it to readers interested in the question for its realistic approach to the matter. It may, however, be pointed out that the report emphasises that at present there is insufficient information to be able to say definitely how far mechanisation under such conditions is practicable, and present indications are that full-scale mechanisation might not be necessarily fully economic; at any rate, for the present, it should aim at supplementing and not entirely replacing the hoe.

And here an article in this issue by Mr. G. B. Masefield on the hand tools used by native cultivators is apposite and to the point. He emphasises that many of these are rudely primitive, not well adapted to the tasks they are intended to perform and very inefficient. He argues, and with justice, that one of the first steps to improvement is the introduction of more efficient hand tools and that, until the cultivator has been educated to the need for this, it is in fact rather hopeless to expect him to be enthusiastic about the advantages of even the simplest tractors, which to his untutored eyes are marvels of complexity and possess an almost unlimited capacity for causing trouble in his untutored hands.

Indeed, the rigid and innate conservatism of the native cultivator is one of the greatest obstacles to be overcome. How many of us who have dwelt in the tropics have not watched with pain the efforts of our ' mahli ' or our ' bibi ' to remove weeds from the garden path or the garden border with a piece of bent hoop iron? How many have been tempted to provide him or her with a more efficient tool in the shape of a scuffle hoe or something similar, only to find to our chagrin the hoe reposing unused in the tool shed, if indeed its handle has not been broken up surreptitiously for firewood, while he continues to perform the task with his accustomed implement in the dear old-fashioned way?

Land planning

THE trenchant letter by Dr. Dudley Stamp on land planning, which appeared in *The Times* of December 22, calls attention to difficulties being experienced in operating the legislation for town and country planning in the United Kingdom at the present time.

A leading article in the same issue of *The Times* comments on the letter and in particular on the plethora of officials which the legislation has evoked and the consequent clogging of action which has resulted. It pleads for a measure of decentralisation by the creation of regional joint planning boards to which detailed work can be delegated, leaving the central authority to concentrate on the big issues.

In this one can agree, but the cardinal point of Dr. Stamp's letter seems to us to be the emphasis which he lays on the need for unified research and inquiry as a prelude to planning. This was placed foremost among the duties of the Ministry in the report of the Scott Commission. It is indeed essential, for without adequate basic data it is obviously impossible to plan anything effectively.

Unfortunately, the truth of this does not appear always to be universally apprehended. Thus, to quote Dr. Stamp's letter, ' the experience of the past seven years has demonstrated . . . our woeful ignorance of essential facts, yet it is this research

aspect which has tended to become eclipsed.... Those whose task it is to undertake investigations do not normally rank in status with executives and find their work swamped by day to day tasks.... Moreover, once legislation has been passed, administrative officers do not welcome disturbing new facts and the conscientious civil servant working from the book may make an ever increasing number of wrong decisions. As a result much land planning policy is based on theories and there is danger of spending millions when a few thousands spent on long range inquiries would reverse the policy.'

Although written primarily about conditions in Britain, these remarks have a universal bearing. Today there is widespread appreciation of the point that land use must be thoroughly planned if production is to keep pace with the demands of ever-expanding world populations. But if planning is to achieve its aim, there must be an adequate basis of ascertained fact behind it. If research reveals that this is inadequate or erroneous, plans must be modified to meet the requirements thus established. Although plans may be far advanced it is impossible for them to succeed if the hypotheses upon which they are founded are erroneous; nature has no respect for preconceived ideas if they do not conform to her requirements, no matter how illustrious their authors may be.

Let us hope that the truth of this may soon become fully apprehended, for time is short, and the cardinal importance of the research worker and surveyor in providing the basis for all forms of development will be fully recognised.

The sooner it happens the better it will be for the world at large and, incidentally, for the pockets of the patient taxpayers who are the source from which development must stem.

Sulphuric acid and agriculture

APART from its use as a weedkiller, the contribution of sulphuric acid to agriculture is largely indirect. It is, however, a most substantial and critical contribution. Roughly 11 cwt. of the acid are required to produce 20 cwt. of superphosphate, and at present some 20,000,000 tons of superphosphate are used in world cropping. The acid is required for manufacturing sulphate of ammonia; in many cases when gaseous ammonia is first produced as a by-product or synthetic product, the alkaline gas is immediately absorbed by sulphuric acid. So long as sulphuric acid was cheap and plentiful—a condition enjoyed in the chemical industry for many years—growers could rely upon low-cost fertilisers. Ever since the end of the war, sulphuric acid supplies have been very tightly balanced with demand. Many industrial users have looked at the situation nervously. Unfortunately, all their fears and doubts have been proved to be more than justified.

For 30 if not 40 years America has dominated the world's sulphur industry by developing the Frasch process for extracting elementary sulphur from the so-called salt domes of the Gulf Coast. No other system of mining can produce sulphur as cheaply. Superheated steam is pumped down into the deposits, the sulphur melts, and compressed air forces it upwards to the surface. Five million tons of sulphur are being produced each year in America by the Frasch mining process. It is said that other sulphur deposits in the world, which must be exploited by hand or mechanical labour, cannot yield anything like this annual output and then only at about twice the cost. But these American deposits are running out. In the few salt domes to which the Frasch process can be applied only enough sulphur is left for another 11 or 12 years. This fact, plus the greater demands of rearmament, has led America to curtail her sulphur-exporting policy. Unless there is some revision of this policy, no more ' cheap ' sulphur is available for the rest of the world.

Sulphuric acid can be made from other raw materials. Sulphur-containing ores like pyrites and spent oxide from gas works can be used. But acid plants based upon these materials cost two and a half times as much as those based on sulphur and they cost four or five times as much to run. Sulphuric acid must increase in cost, and countries which have been recently and entirely relying upon American sulphur must also pass through a difficult period of acute shortage of acid. One very likely consequence is a greater use of mineral rock phosphate. This may not be wholly desirable, but it could become the only practicable policy for maintaining the total phosphate needs of intensified agricultures. Another possibility is the use of nitric acid to ' solubilise ' the phosphate in rock phosphate, thus developing nitro-phosphatic fertilisers of the kind that have been pioneered in post-war Holland and France. An ill wind never blows without some good. The sulphuric acid crisis may hasten the development of alternative fertilisers for superphosphate and sulphate of ammonia, and some of these may in the end be found to offer special advantages. Meanwhile, however, the situation is serious.

THIS MONTH'S COVER

A delightful picture of controlled grazing in Western England. Notice the unobtrusive but efficient electric fence and the efforts of some of the grazing animals to circumvent it.

(Photo: Wolseley Sheep Shearing Machine Co., Ltd.)

Soil Structure

Its Importance in Crop Production

E. W. RUSSELL, Ph.D., M.A.

Department of Agriculture, University of Oxford

Efficient agriculture largely depends on maintaining satisfactory structure in the soil. The factors which contribute to this are complex and only of recent years have some of them come to be appreciated; even today the whole story is by no means completely elucidated. In this authoritative article the subject is discussed and the present state of knowledge described.

FARMERS and estate managers all over the world have become aware of the very great importance of soil structure in productive and conservative systems of agriculture by noting the very grave difficulties that arise when they try to grow crops on soil which has lost its structure. It is also increasingly being appreciated that many of the basic problems of soil conservation involve the conservation of the soil structure, and that soil erosion is fundamentally a consequence of loss of soil structure.

Soil structure, unfortunately, cannot be given an adequate definition in a few words, nor can it yet be measured by a simple figure, for the reason that this term includes several different soil properties, and the particular property of most importance for any particular soil depends on local circumstances.

Pore space in soils

There are many ways of looking at soil structure, but here it will be first described from the point of view of the requirements of the plant roots; for one of the essential functions of the soil is that it should form a suitable environment for healthy root development. It can only fulfil this function properly if it contains pores or channels wide enough for the roots to grow in, if there is an adequate water supply in contact with the roots, and if the oxygen content around the roots is fairly high and the carbon dioxide content fairly low. Now these three properties are simply properties of the pore space distribution. This is obvious for the first of these properties, but not for the other two. Water can only be held in pores against the force of gravity if it is in pores smaller than about 30-60μ in diameter (1μ=0.001 mm.=1/25,000 inch); hence a well-drained wet soil has air in all the pores larger than this, and water in the pores smaller; the greater the volume of these smaller pores, the greater the amount of water the soil can hold against drainage. The aeration of the soil, that is the proportion of carbon dioxide to oxygen in the soil, depends on the volume of pores containing air, but not on their size; and the greater the volume of air in a soil, the lower its content of carbon dioxide and the higher its content of oxygen: the better, in fact, it is aerated. Hence the goodness of aeration of a soil becomes worse as it becomes wetter, and for well-drained soils it is at its minimum when the soil is in its wet but well-drained condition—at its field capacity as it is called. Now this proportion of pores that can be emptied of water by drainage, which is so important for the aeration of the soil, is one of the most important manifestations of soil structure from the point of view of the plant roots, so that any discussion of soil structure, as it affects plant growth, must be concerned with the size distribution of pores in the soil.

Photograph of a Rothamsted soil profile showing structural cracks down which water can percolate

Pore space distribution

The pore space of a soil consists of all the spaces in a soil that are not filled with solid particles. The shapes and interconnections of these spaces are, however, extremely difficult to describe and one has only got to try and describe the shape of the spaces between a heap of tennis balls to realise this. Fortunately, there is no need to describe what the pore space looks like, as we will only be concerned with a few of its properties. One of the most important is that there should be a system of pores, cracks or channels extending from the soil surface to below the root zone down which rain or irrigation water can move sufficiently rapidly to prevent the carbon dioxide of the soil air building up to so high a concentration that it harms the plant roots, but yet sufficiently slowly to allow the top layers of the soil to soak up all the water needed to bring it back to field capacity as it percolates downwards. Water only moves at a reasonable rate through pores that exceed 10-30μ in diameter, that is a little smaller than the lower limit of the size that can be emptied by drainage, so that pores of at least this size must extend from the actual surface of the soil downwards.

Soil texture and structure

Now the pore space distribution in a soil primarily affects the property known as its texture—a clay soil, which is a textural description of a soil, is one having a mass of very fine pores between very small particles, whilst a sand has fewer and wider pores between larger particles. A well-puddled moist clay has a nearly uniform system of pores permeating the whole mass, but they are all too fine to be emptied of water by drainage, so such a soil would hold a large volume

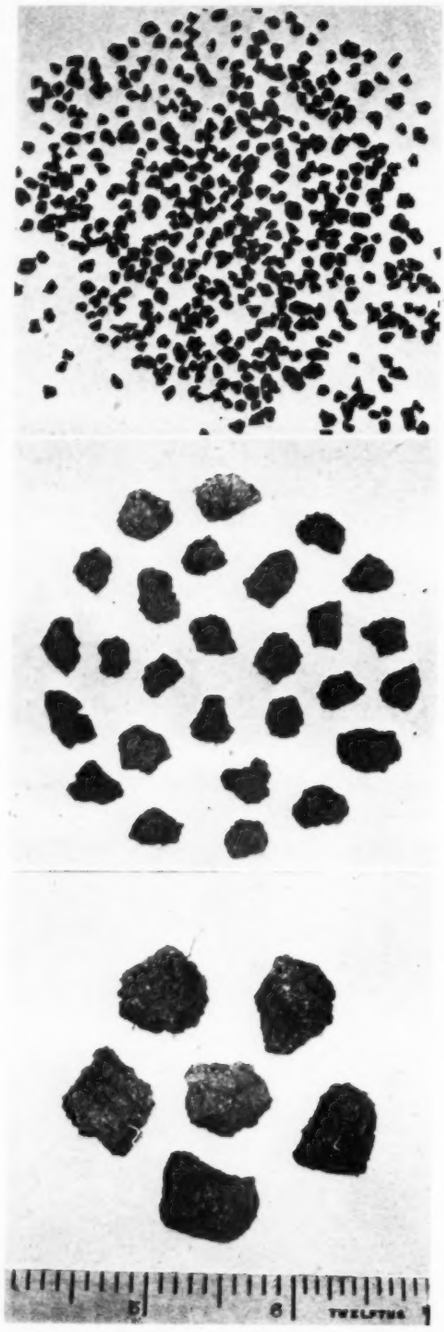
of water against drainage. But it is useless as a medium for root growth both because the pores are too fine for roots to penetrate, and also because there are no means of getting oxygen into, or carbon dioxide out of, the main mass of the soil when it is wet.

A well-structured clay differs from a puddled poorly structured clay in that there is a well-developed system of fairly fine cracks ramifying throughout the body of the former, whilst the latter will have no cracks at all when wet, and when dry will only have a few wide cracks, cutting off large solid blocks of soil. Structure manifests itself therefore as a system of cracks cutting across the uniform system of textural pores between the soil particles; and one can define increasing goodness of structure by saying that the smaller the volume of soil particles which only have textural pores between them the better the structure. This is a perfectly reasonable definition of structure, but it has the disadvantage that nothing is said about the width of the cracks between these structural units, and if the structural units become too small, so do the cracks, for they will no longer be emptied of water by drainage. Some workers have tried to overcome this difficulty by calling the fine structural cracks that cannot be emptied of water by drainage the micro-structural pores, whilst those that can be so emptied are the macro-structural pores.

Micro- and macro-structures

Though the micro-structural pores play no part in soil aeration, yet they can affect several other important soil properties. Thus a soil devoid of them would feel very plastic when wet; and in fact the more one puddles a moist soil, the more plastic it becomes because these micro-cracks are destroyed in the process of puddling. Further, a soil with no micro-cracks dries into very hard clods, whilst a soil full of them dries into softer, more crumbly crumbs. Thus the distribution of these micro-crumbs is probably responsible for the property of the soil known as the mellowness or rawness of its tilth: a mellow soil will be filled with an intimate system of these cracks, whilst a soil with a raw tilth will only have a few.

The macro-structural pores primarily affect the permeability of the soil to water, and its aeration; and a soil can only be well aerated if these pores come fairly close together. These pores are usually present as a system of cracks wide enough to be emptied of their water by drainage, but they need not take this form. In extreme cases these macro-structural pores are present simply as vertical channels in the soils, such as root channels, worm channels, or even channels due to woodlice, which are reported to burrow extensively in the soils of some of the Russian steppes. As long as these channels are close enough together to aerate an adequate volume of the soil, they will be fulfilling their function as structural pores.



Examples of three different types of soil crumbs. A reduced inch scale gives an idea of their real size

Normally, however, the macrostructural pores are present as a series of cracks, wide enough over some of their cross-section to be emptied by drainage, and an important property of this system of cracks is the size of the structural units enclosed by it. These units are displayed as the crumbs or clods a soil breaks up into as it dries, and they can often be best seen by dropping a dry clod of soil on to a concrete floor. A soil with a well-developed macro-structure will break up into characteristically shaped structural units known as crumbs if they are fairly small and clods if they are large.

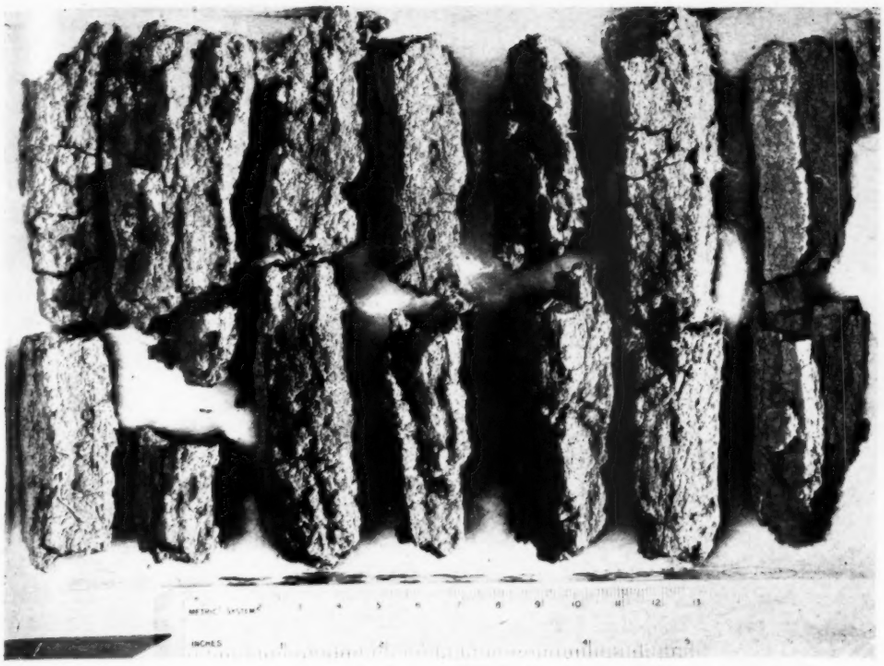
Definition of soil structure

We are now in a position to define what is meant by structure in more detail. Soil structure in loams and clays can either be thought of as a system of cracks surrounding soil crumbs or clods, or it can be considered as a system of crumbs or clods surrounded by cracks, so that these crumbs or clods can be said to be individual entities. It is a matter of convenience in any particular case which of these two aspects of structure—the pore space or the crumb—one chooses to focus attention on. The advantage of thinking in terms of the cracks rather than the crumb is that it is the cracks which are the operative part of the structure, for it is they which control the goodness or badness of the soil aeration in the root zone. Also, as already pointed out, soils can have an adequate system of wide non-textural pores, such as those produced by earthworm burrows, which confer on the soil the physical properties needed for good root development, without there being any development of crumbs or clods.

Clays, loams and sands

Structure is thus seen to be of fundamental importance in clay and loam soils, and on the face of it of but little importance for sands. The reason this last conclusion is wrong is because sand particles go down to 20μ in diameter, and the pore size between such particles is less than their diameter, that is, less than 20μ. Hence, only if sands contain mainly particles larger than 60μ could drainage give a well-distributed air space throughout the soil.

Sands illustrate very well an extremely important aspect of soil structure. The primary importance of structural pores is that they are normally the channels through which moist soils are aerated, but they can only fulfil this function if they extend from the surface of the soil downwards. It does not matter how favourable the size distribution of the pores is in a soil, if there are an inadequate number of pores containing air in the top tenth of an inch of surface soil, that soil will be badly aerated. If a coarse sandy soil contains any



Vertical structural units that can form in some heavy or rather structureless soils

sand particles smaller than about 60μ, and these particles block the larger pores between the larger sand particles in the surface crust of the soil, that soil must be badly aerated as long as the surface crust is moist. This is just what sometimes happens when a sandy soil caps badly after rain, and this cap, by being impermeable to air when wet, can cause the carbon dioxide content in the soil to rise rapidly to so high a value that all the delicate feeding roots of the crop are killed.

Good structure criteria

We are now in a position to say what we demand of the soil structure: it is that there shall be a well-distributed stable system of pores which are wide enough to be emptied of water when the drainage is good. These pores must start in the soil surface itself and be of sufficient volume for the percentage of oxygen in the soil air never to fall so low, or that of carbon dioxide to rise so high, that the feeding roots of the crop are injured. The percentage of the soil volume that must be occupied by these pores for this condition to hold is not known with certainty, but 15% is a good figure to aim at, although soils with less than this may be adequately aerated, particularly in cool weather.

Restoring damaged structure

The problem of restoring the structure to a soil that has lost it falls into two parts: putting the original, or an adequate system of structural pores back into the soil, and then ensuring that these pores are long lived. Putting structure back temporarily often is not very difficult—good cultivations will normally do this, so will getting a crop to grow on soils which shrink on drying, for the mere drying of the soil by a crop during dry weather will usually cause a sufficient number of cracks to develop. Normally the difficult problem is to ensure that these cracks will have a reasonably long life.

Structural stability

This is the problem of the stability of the soil structure, and whilst it is fundamental in many problems of bringing back into cultivation land which has been devastated for one reason or another, it is of considerable importance in all problems of conservative farming. But whereas up till now it has been more convenient to think of structure in terms of the pore spaces in the soil, it is more convenient to think of the stability of the structure in terms of the stability of the structural aggregates or crumbs themselves; for an unstable structure is one in which either the crumbs break down on wetting or particles from the surface of the crumbs flake off and block the structural pores.

The problem of stability of structure can therefore be thought of as the problem of ensuring that the cements that hold the soil particles together into crumbs are as strong as possible, particularly when the crumbs are wet. The part of the soil in the field where this stability is of most importance is the superficial layer, for here the disintegrating effects of climate, cultivation machinery and the trampling of livestock are most active.

Soil particles can be held together in crumbs by four different cements: by the clay particles themselves, by hydrated iron oxides and possibly also by alumina and silica cements, by certain components of the soil organic matter, and by living and perhaps dead organisms such as some micro-organisms and the roots of some grasses. These cements fall into two categories—the inorganic, over which the farmer has relatively little control, and the organic over which he can exercise very considerable control.

Clays as cements

Clay particles are the most important cements in many temperate soils. A clay soil always tends to have its particles bound together into crumbs or clods, whilst in a sand the particles tend to be loose. Thus the great problem in clays is to encourage the formation of fairly small crumbs—to weaken the clay cement in fact, whilst in sands it is to bind the soil particles together. But not all clay particles have this property of being able to cement soil particles together into clods: it is restricted to clays having an appreciable power of holding bases, that is, to clays of the micacous type but not to those of the kaolinitic type. Now the clay fraction in most temperate soils contains an appreciable proportion of micacous clays, but this is not true for many tropical soils —their typical clay is kaolinite, which does not possess the power of binding soil particles into crumbs. However, these tropical kaolinitic soils often have their clay and silt particles cemented together into crumbs, which may attain the size of coarse sand grains, by hydrated iron oxide cements. When this cementation is at its optimum for plant growth, as it is in many tropical red earths, it gives a well drained, well aerated soil of very great structural stability, which can therefore be kept in cultivation comparatively easily. But a cement of this type can sometimes have a very harmful effect on structure, because, for reasons that are not yet known, it will act as an almost irreversible cement when the soil is dried in the sun, binding the soil particles together into lumps as hard and almost as permanent as bricks. In fact where these soils, or rather subsoils, occur, they are often used as building bricks, and it was this material that Buchanan first called laterite in 1807.

Iron cements

The iron cements appear to be relatively stable, and the farmer can only accept

them gratefully where they occur. Without them, many of the kaolinite clay and silt soils of the tropics would be almost uncultivatable because of lack of structure. But this need not be true for the micacous clays. Their particles, wrongly worked, can act as too weak a cement when the crumbs are wet, allowing the coarser pores to be blocked by the flaking off of fine particles from their surfaces when they are wetted after being dry, and too strong a cement when the soil is dry so that, instead of developing a mass of small closely spaced cracks throughout the soil mass as it dries and shrinks, it only develops a few large widely spaced ones. Such puddled or poached clay soils, which have lost their structure, can only have it restored slowly. The principal methods for doing this in the temperate regions are either to leave the large clods exposed to the mellowing action of the weather, for repeated wettings and dryings and freezings and thawings slowly break them down, or else to put the land back or let it fall back to forest or grass.

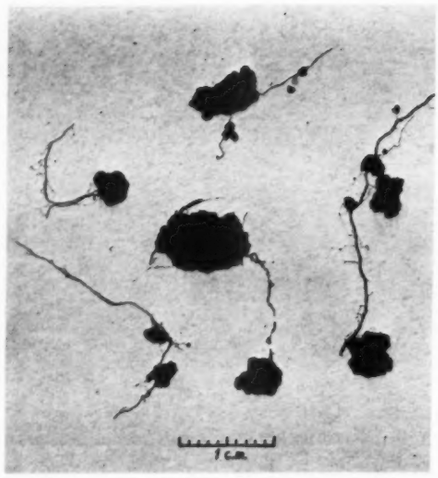
Organic cements

The effects of the organic cements are much more within the control of the farmer. These cements are the principal agents that can be used in practice to impart and maintain a suitable structure in sand and silt soils, and these same cements, by being apparently weaker than clay particles, weaken the clods in clay soils, making them more friable and hence encouraging a more intimate system of coarse pores to develop. It is possible that the most important effect of organic manures in most soils, and in fact the principal justification for using bulky organic manures instead of fertilisers, is because of the very beneficial effect of the manure on the soil structure.

The mode of action of the cementing substances produced during the decomposition of added plant and animal remains in the soil is not yet known, nor is it certain what classes of substances are responsible for the cementation. One definite fact is known, namely, that only some of the substances which contribute to the soil organic matter are active. Badly farmed prairie soils may contain appreciable amounts of organic matter which have little, if any, power to bind soil particles together, and badly farmed peat and fen soils can easily fall down to a loose powder in dry weather and become very liable to blow.

Microbial lignins and gums

Only two groups of compounds present in the soil organic matter are likely to be important as structure formers, namely,



Soil crumbs held together by grass roots, and probably produced by the roots

some dark-coloured substances derived from the partial oxidation of plant and microbial lignins and more or less colourless gums and mucilages produced as by-products of microbial action. Both these types of material will aggregate sand and silt particles into crumbs in the laboratory, and there seems little doubt that the dark-coloured substances are of importance in some temperate soils. But it is not yet certain if the structure produced by microbial gums is of any importance in the field, nor if the gums occur in sufficient quantity, and are sufficiently uniformly distributed throughout the soil, to influence the structure appreciably. They may, however, be of importance in some tropical soils, for there are some brightly coloured tropical soils which contain an appreciable content of organic compounds that do not darken the soil colour as much as the same amount of organic matter would do in temperate soils. There is a little circumstantial evidence that these soils contain a high proportion of microbial gums and a low proportion of partially oxidised lignin compounds. But unfortunately the effect of this light coloured organic matter on the structure of these soils has not been investigated.

The action of roots

Some living organisms have a profound effect on soil structure, and the most striking example is the power of the roots of some, but by no means all, grasses and legumes to bind the soil particles together into stable and characteristic crumbs. This binding action appears, in the first instance, to be due to the living root but it may persist for some time after the root has died. The cause of this binding power is not yet known, though it may be connected with the bacterial or fungal population on the root surfaces, nor is the cause of the persistence of this power after the death of the root, though that may be connected with the length of time the dead root fibres remain mechanically strong. The use of suitable grass and legume leys, when they can be used, is normally a much more effective way of building up soil structure in sands and silts, or ameliorating it in clays than by the addition of the kind of dressings of farmyard manure or compost to the soil that are normally practicable.

The action of fungi and bacteria

Grass and legume roots are not, however, the only living organisms that can build up structure, though they are the only ones that have been proved of importance in the field. One can show, in the laboratory, that the hyphae of typical soil fungi can bind sand and silt particles together, so also can those soil bacteria that either excrete gummy substances or are surrounded by gummy capsules; but the importance of these effects in the field is not known. As was indicated in the previous paragraph, the reason that some grass and legume roots are effective as structure formers may be that they carry on their surface a large number of suitable bacteria and fungi that are capable of strongly binding soil particles together in these conditions because, by being anchored on to the framework of the root system, they have only to exert their effect through small thicknesses of soil. A further possible reason why these roots are effective is that the bacteria and fungi living on their surfaces produce as a by-product of the decomposition of their own bodies a very strong organic cement. A Russian worker has in fact claimed to have increased the effectiveness of grass roots as structure improvers in short-term leys by inoculating them with a suspension of bacteria taken from the roots of these same grasses but growing in old well-structured pastures. Unfortunately, neither of these possible explanations has yet been adequately tested in the laboratory, and it is not possible to decide if they are adequate to explain the power possessed by some grass and legume roots to improve the soil structure.

Earthworms

Earthworms are another group of soil organisms that have a great effect on soil structure in the temperate regions for two different reasons: the making of channels from the surface down into the subsoil and the general loosening of the surface soil on the one hand, and the making of wormcasts on the other; the relative importance of these effects depends

markedly on the species of worms present. The former effect is a simple physical one, affecting the structure through the production of a number, and sometimes a very large number of coarse pores in the surface and subsurface layers which, on some soils, improve the drainage and aeration sufficiently to have a very beneficial effect on crop growth.

The reason wormcasts have a better soil structure than the surrounding soil is not yet known definitely. It may be because some specific gums or mucilages are produced in the worm's intestinal canal, but present evidence indicates it is mainly due to the intimate mixing of finely ground organic matter, soil and calcium carbonate that goes on in its gut. The cast is richer in organic matter than the soil around, for the worm probably feeds on dead plant tissue and hence selects volumes of soil containing plant residues and therefore richer in total organic matter than the soil as a whole.

Soil structure and soil management

The reason that there is so often a problem of maintaining soil structure in cultivated as opposed to virgin land is that all methods of intensive land use, whether arable or grazing, tend to destroy the intimate distribution of coarse pores that exists in the virgin soil from the soil surface downwards. This problem must therefore be solved by developing methods of management which will allow an adequate system of coarse pores to be maintained, and the most critical place, and the most difficult, is the actual surface itself. The principal causes of the destruction of the coarse pores and the structure in the surface itself are the shattering action of rain drops, particularly large fast-falling rain drops on bare soil crumbs, and the compaction of the soil surface by trampling or other means when the soil is wet. It is, in theory, always possible to minimise the shattering action of rain drops by keeping the soil surface covered, either by a crop or by a mulch of dead vegetable matter, but great difficulties may arise under normal farming practice when neither of these methods can be used. The problem is in fact exactly the same as that of controlling soil erosion or water run-off; for every method of decreasing run-off, or in other words of increasing the rate of infiltration of water into the soil, depends for its effectiveness on the fact that it increases the proportion of coarse pores in the soil surface that can resist destruction during these critical periods, that is every method depends on improving the structure of the surface soil and increasing its stability.

Production of the hybrid sunflower variety 'Advance' at Morden Experimental Farm, Manitoba, Canada. On the left of the picture is the tall inline from which the bees transfer pollen to the shorter inline in the middle to produce the hybrid seed

The Sunflower

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Sunflowers have been cultivated as an oil seed crop in Russia since early in the nineteenth century. Of late years, however, cultivation has extended greatly, notably in Argentina but also in a number of other countries, and it is now one of the major oil seeds of the world.

WHETHER the sunflower (*Helianthus annuus*) originated in Central or South America is still a matter for debate, but the available evidence indicates that by the time Cortez set foot on the shores of Mexico, the sunflower was a food crop. It was, however, as a flower of the New World that the sunflower was introduced into Spain in the sixteenth century and for the next three hundred years remained an ornamental plant, hardy enough to be planted in most European and British gardens. By the end of the eighteenth century the possibilities of extracting oil from the seed had been recognised in England, but it was left to the Russians in the next century to develop the sunflower as an oil seed crop.

History

The first centres of cultivation were in the Caucasus and South Russia, but in a relatively short time production spread round the periphery of the Black Sea and sunflowers became part and parcel of the agricultural systems and diet of the peasants in the Balkans. For a long time the production in Russia and the Balkans by comparison dwarfed the output of the rest of the world, but in the early nineteen-thirties there was a new development. Up till that time the Argentine had been an importer of cooking oil—principally olive oil—but the uncertainties of the supply position combined with the rising cost, due in part to the Abyssinian War, caused a reversal of policy. It was decided to replace olive oil by home-produced sunflower oil.

Sunflowers appear to have been grown in the Argentine as early as 1873, but compared to linseed had remained in the background and even in the province of Buenos Aires, the main producing area, the acreage in 1930 only amounted to 11,000 acres. In 1934-35 the acreage had jumped to 150,000, and two years later it was 300,000. As a result of World War II the Argentine acreage continued to expand and next to the U.S.S.R. now has the largest output.

World production

Published information of the world acreages is incomplete, but estimates of the crop production in 1948 made by the National Farm Chemurgic Council are

shown in Table I. It is seen that Roumania and Hungary are still large producers, followed by Turkey and Uruguay, while the Union of South Africa and Canada are newcomers.

TABLE I

ESTIMATES OF SUNFLOWER SEED PRODUCTION FOR 1948

Country	Production (short tons)
U.S.S.R.	2,500,000
Argentine	1,025,000
Roumania	440,900
Hungary	389,000
Yugoslavia*	128,000
Turkey	88,100
Uruguay	49,200
Union of South Africa ..	40,000
Chile	35,500
Canada	11,200
United States	10,000
Italy	8,000
France	7,700

*From FAO statistics.

Varieties

When the sunflower was first grown in the Black Sea area the crops consisted of ' giant ' types with a long-growing period, and the further expansion of the acreage to the north and east was precluded by the lack of early maturing types. Earliness was not only demanded by the shorter frost-free period but also because in many areas the hot drying winds so characteristic of the late summer caused severe damage to crops which had not yet reached the ripening stage. Investigations were therefore set in train to select early types, and almost inevitably this also meant the selection of dwarf varieties. Today so successful has been the selection at Saratov and other centres that the limits of intensive cultivation now extend to latitude 55° North, while the earliest varieties have a growth cycle, under favourable conditions, of 70 days. It has also been found that in Siberia within the same limits of latitude different varieties are required, and at the Barnaul State Breeding Station types have been evolved which will ripen in the neighbourhood of Tomsk.

Harvesting methods

Prior to World War II, in the Balkans, the Argentine and other countries such as Southern Rhodesia there was not the same emphasis on early maturity, for the growing seasons were longer and the giant types did not take an undue time to ripen. In addition, the crops were largely harvested by hand and there was a saving in labour by having a relatively low density of plants, each with a large head. Methods of harvesting differed between countries. In the Argentine the head was—and still is—cut off with a sharp knife, the stem shortened and the head impaled face downwards on the stem to dry out. An alternative technique sometimes used elsewhere is to twist the head on the stem so as to break the conducting tissues but still leave the head attached to the stem. When the seed is ripe the heads are carefully collected to avoid shattering and loss of seed and threshed, either in a threshing machine or by such simple devices as holding the head against a rotating wooden wheel studded with nails.

With the outbreak of the second World War the consequent shortage of edible oils focused the attention of research workers in Canada and Great Britain on the possibilities of the sunflower as an oil seed crop. In the absence of abundant and cheap labour it was apparent that the crop could not be economic unless it was capable of being mechanically harvested, preferably with standard makes of combine. It therefore followed that the first criterion of selection was the production of early relatively dwarf types.

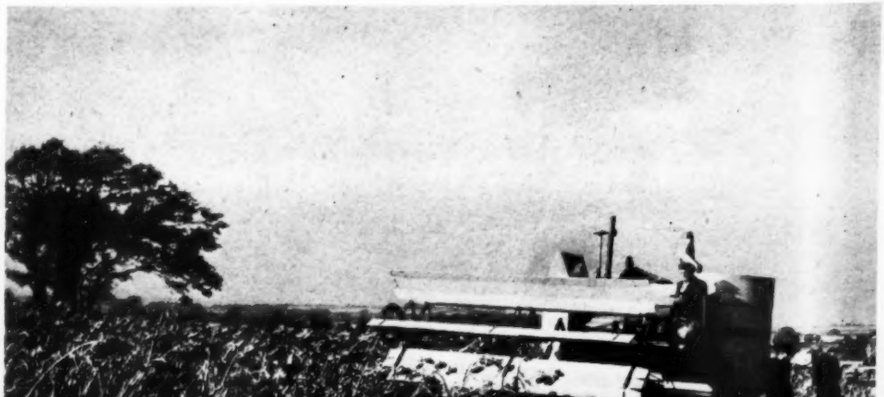
In both countries the main source of material was originally of Russian origin. At Saskatoon Canadian plant breeders produced ' Sunrise,' which was superior to the mixed early type which had been grown by the Mennonites on a small scale. In England two selections of ' Pole Star ' with grey striped seeds and ' Jupiter ' with black seeds proved to be early enough in a normal season for the crop to be combine harvested in the drier districts and on lighter soils of the south and east. With a third somewhat later variety, ' Mars,' the only feasible method was to cut off the heads by hand and thresh them in a maize sheller with a helice type drum. Whichever the method employed, the seed had to be artificially dried before storage, a safe moisture content for bulk storage being 11-12%.

In the Canadian and British trials on harvesting techniques, it was found that only simple and inexpensive modifications were needed for the direct combining of the crop—such as adding an extra slat to the reel and the fitting of extension fingers to the cutter bar. More recently it has been found in the Groundnut Scheme that harvesting is improved by the fitting of a sorghum extension cutter bar.

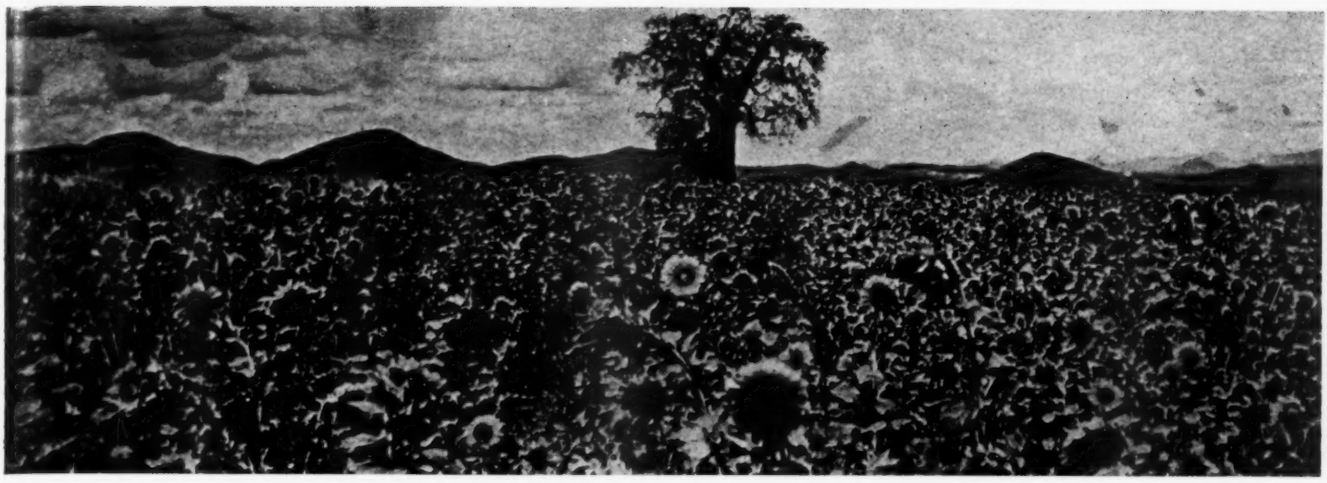
As a result of these wartime investigations, coupled with the continued shortage of edible oils in the post-war period, these dwarf varieties, together with another early variety, ' Mauthner's Hungarian,' have been tried out in many parts of the world. Indeed, it is a remarkable tribute to the adaptability of the sunflower that the English dwarf selections have ripened seed successfully in French Morocco, Israel, Nigeria, Kenya, Tanganyika, South Africa and Australia.

Moisture requirements

Apart, however, from the advantages of mechanical harvesting, the dwarf varieties with a shorter growing period and smaller leaf surfaces can be grown under more arid conditions than the giant types. In South Africa relatively widely spaced crops have given reasonable yields of seed when less than 10 in. of rain have been received by the crop. It is, however, an essential requirement that the rainfall is evenly spaced over the growing season. Where heavy rain is interspersed with dry periods experience in Tanganyika has shown that such conditions are highly inimical, especially in the early vegetative phase.



Combining sunflowers in England. This picture was taken during the first trials which were made during the war



Some of the 21,000 acres planted to sunflowers at Kongwa, Tanganyika, in 1948

Under favourable conditions of rainfall and in deep soils with good drainage sunflowers are capable of giving high yields of seed. In Uruguay and the Argentine first-class crops will produce over 1,800 lb. of seed per acre, while average yields are 900-1,100 lb. Similar average yields have been obtained in Canada where cultivation centres round the co-operative crushing mill at Altona in Southern Manitoba. In England yields are somewhat higher, the maximum recorded being 2,600 lb. per acre—similar high yields have on occasion been obtained in Southern Rhodesia.

Manurial requirements

The sunflower has a highly efficient root system, combining depth of penetration with a large lateral spread in the surface layers. In consequence, except in highly deficient soils, the response to added mineral nutrients is not large. In the tropics and South America applications of phosphorus may be economic, while in Europe there may be a gain by adding nitrogen. Except in extremely deficient soils additional potassium is not required. Indeed, the ash obtained from burning the resinous stems as fuel is so rich in potassium that it has been used as a fertiliser or for glass manufacture. Of the trace elements, the sunflower is said to be extremely sensitive to boron deficiency.

Pests and diseases

Although the sunflower has a wide adaptability to soils and climate, change in environment may still be an important factor in successful production. In cooler and moister climates, such as Great Britain and Sweden, the greatest disadvantage is the liability of the ripening heads to be attacked by the mould *Botrytis cinerea*. The incidence is particularly heavy in wet autumns and large losses may occur. More widespread in warmer climates is the damage that may result at an earlier phase of development when in wet spells the base of the stem may be attacked. Sunflower rust is also very prevalent in the Balkans, U.S.S.R. and elsewhere, and attempts are being made to breed or select resistant types. A virus disease has also been reported in the Argentine.

In the seedling stage the plants may be destroyed by wireworms and cutworms, while in the U.S.S.R. and the Balkans broomrapes (*Orobanche* spp) are parasitic on the roots. This source of loss has been largely eliminated by the production of resistant types. Similarly, by selection, populations resistant to the sunflower moth have been obtained. Here, resistance lies in the morphological structure of the husk, the 'armoured layer' of resistant types preventing the entry of the caterpillars. In the Argentine locusts and the army worm are common pests; in Africa on some soils termites may cause damage, and in Uruguay ants.

Lastly, in the catalogue of pests come finches and many other species of birds who with the domesticated parrot find sunflower seed highly attractive. Such depredations during the ripening phase are particularly serious when the crop is being introduced into new areas, where the initial acreage will be small. But even when the acreage is very extensive, in some countries like the Argentine losses due to birds may still be considerable. The losses are least in varieties having a flat head with well-arched stem so that the disc of the influorescence faces downwards.

The essential beneficial insects are bees to ensure cross pollination because the florets are largely self sterile. In areas with a short and single rainy season, such as in some parts of East Africa or in the treeless steppes of the U.S.S.R., a shortage of bees may be a limiting factor to maximum production and the production of sunflower honey serves a dual purposes.

Hybridisation and selection

Advantage of self sterility in sunflowers has been taken by Canadian plant breeders to produce the hybrid variety 'Advance,' using the natural bee population to cross two relatively self-sterile inbred lines grown in contiguous rows. In this way hybrid vigour can be imparted together with the characteristics of single headedness, uniformity in height and little variation in the maturity date; all of which cheapen and ease direct combining. Since the inbred lines must be maintained and crossed to produce fresh hybrids each year, skilled supervision is required and the cost of the seed is higher than that for the normal varieties. On the other hand, the quantity of seed normally sown per acre is small—4 to 15 lb. per acre.

Much selection has gone into raising the quality of the seed through the elimination of a thick husk, an increase in the proportion of the kernel, and an increase in the oil content. By such methods Soviet plant breeders claim that the oil content of the seed can be raised to over 40% as against the normal range of 25-35%.

Sunflower seed oil

It is a fallacy that sunflower seed from the subtropics or tropics contains more oil than seed from temperate regions: in fact, the general trend is in the opposite direction. There is also another difference, namely, the composition of the oil. Investigations in Professor Hilditch's laboratory have shown that the oil from English-grown sunflower seed contains an appreciably

(*Concluded on p. 56*)

Insecticide-Fungicide Seed-Dressings

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The use of organo-mercurial seed-dressings to protect growing crops against seed-borne fungoid disease was an outstanding development of the second and third decades of the present century. A recent extension has been their use in association with gamma BHC to provide protection against wireworms and similar harmful soil inhabiting organisms.

THE chemical treatment of cereal seeds, and particularly of wheat, goes back according to the records to at least the seventeenth century. But until very recent years the sole object was to control certain deleterious fungi, such as stinking smut or bunt of wheat. With the advent of the new synthetic insecticides of extreme potency new techniques of seed dressing have not only largely solved the problem of the control of insect pests in the storage of grain, but have enabled a large measure of protection to be given to germinating seedlings against soil insect pests, notably against wireworms.

To understand the present position we must trace the various steps of the development. Most of the serious fungous troubles of cereals, except the rusts, are seed-borne. That means that the diseases survive and are carried over from season to season by means of spores or mycelium on or in the seed. Furthermore, most of the worst of these seed-borne diseases are capable of being controlled by treating the infected seed with various chemical agents.

Between the end of the seventeenth century and 1895 the crude methods employed included steeping in brine, steeping in dilute copper sulphate, later steeping in copper sulphate solution followed by the addition of quick-lime, and so on. In 1895 the formaldehyde steep was introduced and has been used to a limited extent right up to the present.

Dry treatment of wheat with copper carbonate dust became popular from 1917 onwards as the result of the work of Darnell Smith in New South Wales, Australia, and is still used throughout Australia to an appreciable extent. As already indicated, however, none of these treatments controlled diseases of importance beyond wheat bunt.

Organo-mercury seed-dressings

The first mention of the now universally used organo-mercury seed-dressings came from Germany in 1914, but it was not until the end of the nineteen-twenties and early 'thirties that they really came into extended use on the Continent of Europe, in Britain and America. The organo-mercury compounds are extremely active fungicides and very dangerous poisons. They are so active, however, that they have proved capable of formulation into dilute solutions and, more recently, into dusts and slurries which are relatively safe in use.

The greatest advantage of these new compounds is that not only are they very efficient against bunt of wheat (*Tilletia caries*) but they also control a much wider range of diseases such as oat leaf stripe (*Helminthosporium avenae*), the covered and loose smuts of oats (*Ustilago Kolleri* and *U. avenae*), covered smut (*U. Hordei*) and leaf stripe and net blotch (*Helminthosporium gramineum* and *H. teres*) of barley, striped smut of rye (*Urocystis occulta*) and several others.

Outside the Americas the organo-mercury dust seed-dressings mainly used contain from about 1.0 to 1.5% of mercury, organically combined, for use at the rate of approximately 2 oz. per bushel of cereal seed (about 0.2%). In America it is much more usual to employ dressings about four times as strong at one-quarter the rate, *i.e.* at ½ oz. per bushel.

Such dressings are applied by simple end-over-end mixers, such as old churns or drums mounted on bearings. On the larger scale fully automatic mixers are used, capable of outputs of hundreds of bushels per hour. Mixing with a shovel on the barn floor is not really good enough and is not recommended.

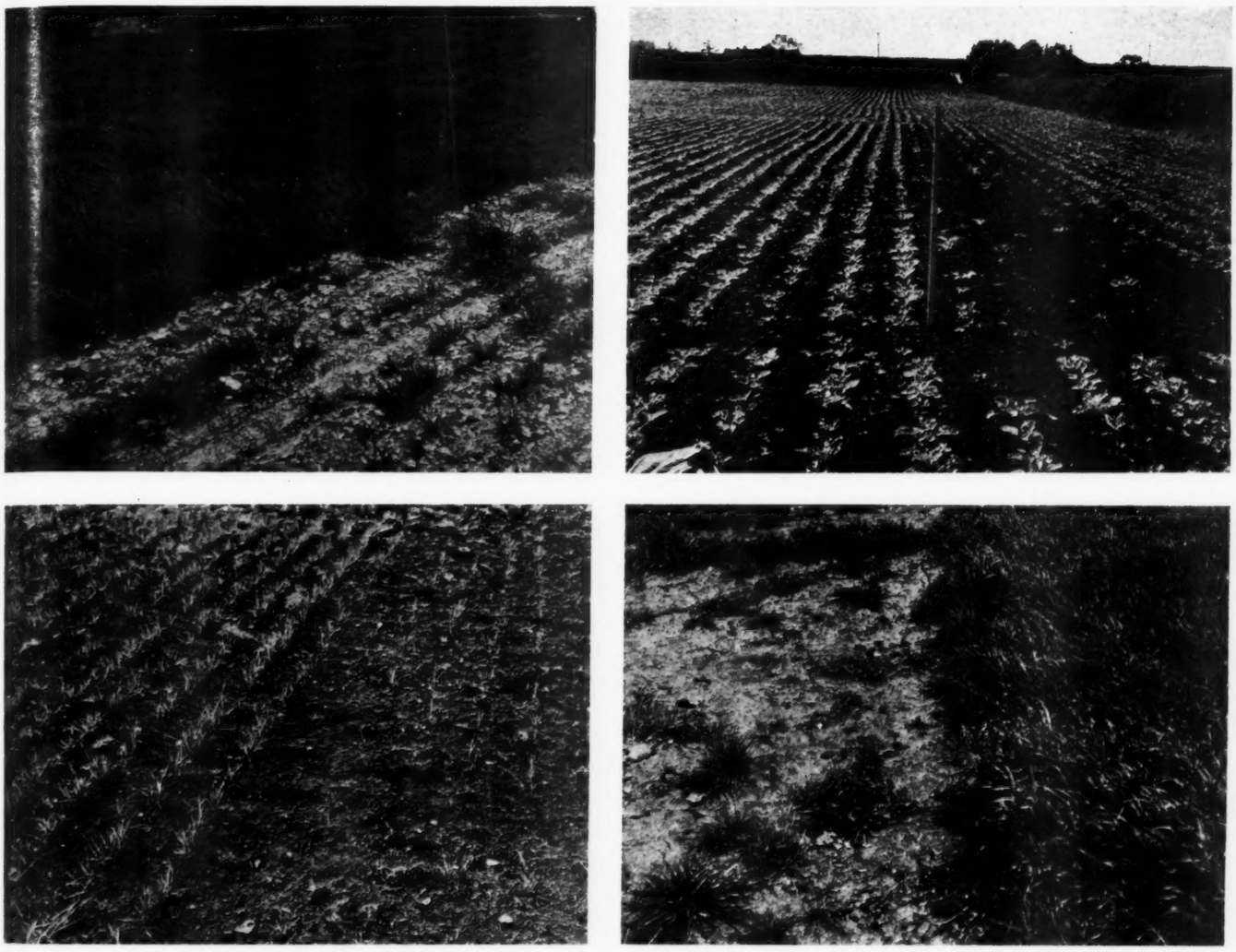
It is probable that somewhere between one-half and two-thirds of all the cereal seed sown in Great Britain is so dressed annually.

The practice has extended in other directions, for example, for the control of seed-borne diseases of maize, millet, cotton, ground-nuts, sugar beet and many others. Judging from Dr. Padwick's recent monograph there should be a very large outlet on rice seed, but except in North America very little has been done in this direction.

Wireworm control

We may now turn to the development of chemical means of control of that most pernicious and widespread soil insect pest, the wireworm (*Agriotes* spp). Less than ten years ago the only means of control, apart from cultural means, was the use of massive doses of naphthalene, something like 15 to 20 cwt. per acre according to the work of Ladell at Rothamsted, or fairly heavy dosages of such unpleasant chemicals as carbon bisulphide, chloropicrin and methyl bromide, all of which are either inflammable, highly poisonous or both. Not only that, but at the dosages required for effective control all these proved quite uneconomic for field-scale farm operations.

It was natural that soon after the discovery of the synthetics, dichloro-diphenyl-trichlorethane (DDT) and benzene hexachloride (BHC), they should be tested as soil insecticides. Some of the first recorded work was at the Hawthorndale Laboratories, Jealott's Hill Agricultural Research Station, Berkshire (Jameson, Thomas and Woodward, *Annals of Applied Biology*, 1947, **34**, 346-356), where it was soon shown that both were reasonably active against all stages of wireworms in cereal land. But some curious anomalies early appeared in the results. When dosages of the order of 5 to 10 lb. of technical DDT (containing 70 to 80% of the para-para'-isomer) and technical BHC (containing 13% of the gamma-isomer) were suitably diluted and applied per acre, the observed kill of wireworms varied from some 30 to 70%. This was, perhaps, rather disappointing, but it was soon followed by the further observation that whereas the DDT treat-



The efficacy of seed-dressings is exemplified in these trial plot pictures. *Top left*—**Wheat untreated and treated with 'Mergamma' A against wireworm attack.** *Top right*—**Untreated sugar beet seed hardly emerged at all (bare patch on right) in an otherwise healthy crop which was treated.** *Bottom left*—**Oats treated with organo-mercurial seed-dressing, except in control plot on the right which has been attacked by disease.** *Bottom right*—**Combined seed-dressing has helped the establishment of direct re-seeding pasture, while wireworms have seriously attacked the control plot on left**

ment allowed, say, a 10 to 50% reduction in stand of such cereals as spring oats, the BHC treatment gave substantially 100% stand, or prevention of damage. This has not yet been satisfactorily explained, but it would appear that the BHC prevents the feeding of the residual, unkilled wireworm population. There is no evidence of repellency.

As a result there has been wide-scale commercial use of BHC dusts, applied broadcast before sowing and harrowed into the soil, at application rates of about 1½ cwt. per acre, supplying some 5 lb. or so of technical BHC. It was later found that almost as good a protection of cereals could be achieved by combine-drill application of about one-third to one-half these amounts per acre.

A serious snag appeared quite early in these investigations. Crude, technical BHC when applied to soils in which such crops as potatoes, carrots and onions are subsequently grown can and does cause serious taint in these crops, even for several years after application. The combine-drill method of application helps but does not entirely eliminate this risk, and both methods have had to be restricted to conditions where there is no possibility of taint-susceptible crops following closely in the rotation. Sugar beet are not susceptible to taint; at least no taint appears in the refined sugar produced from sugar beet grown in land containing sufficient BHC to produce serious taint in potatoes.

As the entomologists at the Hawthorndale Laboratories were working alongside specialists in seed-treatment work it was a fairly obvious next step to see whether gamma-BHC could be applied to seed in sufficient amount to prevent significant wireworm attack on the seedlings after sowing. The work proved most promising. Not only did the experimental dressings prevent damage from all but the heaviest wireworm attacks, but it proved possible to combine the gamma-BHC with the ordinary organo-mercury seed-dressing so that only a single application was required.

Such a dressing has now been available commercially for several seasons in Britain and the general picture is quite clear. A combined dressing will control all the usual cereal seed-borne diseases and give very substantial protection against wireworm attack. It is not quite so efficient

as the broadcast treatment, but it is completely free from the taint hazard in subsequent crops and is very substantially cheaper. Only when the wireworm population is very high, say, 1,000,000 or more per acre, especially with a poor seed bed, does the new type of dressing fail to give adequate protection.

Comparative costs in Britain run as follows: broadcast dust treatment against wireworm alone costs approximately 60s. per acre for material, plus a few shillings per acre for application through a fertiliser distributor. Use of a combine drill involves a cost of 20s. to 30s. for materials, again plus the cost of application. The combined seed-dressing costs only about 12s. per acre, there is no extra application cost, and if we deduct the value of the straight organo-mercurial effect at, say, 2s., the net cost of wireworm protection is only 10s. per acre.

At this level of cost many farmers consider the treatment well worth while as a measure of insurance wherever there is any risk of wireworm attack. As already indicated, however, it is not adequate when really excessive populations of wireworm are present and the treatment should not be pushed beyond its capabilities.

Such excellent results have been followed up in a variety of other directions. The product used for cereals was tried on sugar beet, but because of the very low seeding rate, 12 to 15 lb. per acre, it is not surprising that the gamma-BHC 'load' on the seed proved too low. However, when the proportion of gamma-BHC in the dressing was suitably increased the same excellent results were obtained and a significant portion of the sugar-beet acreage in Britain was so treated in 1950. The resulting improved establishment of plants has simplified singling operations, in some cases has provided a worthwhile stand where the control plots were almost bare, and has given some remarkable increases in final yields.

Similarly on direct-reseeded pastures, which are very subject to wireworm depredations, such dressings have given excellent results.

Overseas developments

Naturally these developments have been followed up in a number of overseas territories. In the prairie provinces of Canada, for example, wireworm damage to cereals is often far more important than damage from seed-borne diseases. Official and farm trials there have shown that application of these seed-dressings, *applying the equivalent of only 1 oz. of gamma-BHC per acre*, gives remarkable protection of wheat against wireworm attack. Furthermore, in some cases the protection has extended into the following two seasons, a truly remarkable finding. Application as low as half that indicated above has given adequate protection in the season of application but does not cause significant reduction of wireworm populations.

Similar work in the United States of America in the past two years shows equal promise against the true wireworm and the false wireworm (*Eleodes* spp).

Such work suggests other applications in other parts of the world which should be well worth following up. So far the dressings have not seemed adequate to protect seedlings against cockchafers, although the few experiments so far conducted are not conclusive. Similarly, leatherjacket damage has not been prevented, which is not surprising when it is considered that they do most of their damage just above soil level. On the other hand, in South Africa, preliminary tests suggest that the damage due to the black maize beetle (*Heteronychus* spp) may be prevented in this way. Will it be possible to stop the ravages of certain termites which attack seed before it germinates, for example, the termite which attacks dura in the Sudan?

The entomologists and the chemists have again produced an outstanding new tool for use in world agriculture. It is already doing a good job in a few countries. A great deal of experimental work is needed before its full potentialities may be assessed.

(Photos: Plant Protection Ltd.)

Sir John Russell

Sir E. John Russell, formerly Director of the famous Rothamsted Experiment Station and ex-President of the British Association, has been on four safaris in Kenya, Uganda and Tanganyika for the British Council, visiting farms and experiment stations, lecturing and attending agricultural conferences.

From East Africa he has gone to India and Pakistan at the invitations of both Governments and from there he will go to the Sudan at that Government's invitation, returning to the U.K. towards the end of March.

Before visiting Africa Sir John, who is 78, attended the Stockholm Botanical Congress, which was held last July and of which he was a *President d'Honneur*, the International Soil Congress at Amsterdam, where he held a similar position, and the British Association Meeting at Birmingham.

Some of our readers may recall that it was Sir John Russell who introduced WORLD CROPS on page 1 of the first issue.

DDT and the Fruit Fly

The Director of Agriculture for Cyprus has asked us to point out that a note entitled 'Mediterranean Fruit Fly Controlled by DDT,' which appeared in last October's issue of WORLD CROPS, reporting results stating to have been obtained by the Department of Agriculture, Cyprus, in experiments on the control of the Mediterranean fruit fly, was not strictly correct. The information was supplied by a correspondent and not by that department which now informs us that the experiments then referred to were a small part only of a number which have been in progress for several seasons in different parts of Cyprus, but which have repeatedly suffered from lack of sufficient occurrence of the fruit fly to give definite results. DDT dust has not been found to give any appreciable control: repeated spraying with wettable DDT appeared in some cases to give reasonable control, as did also a lead arsenate-sugar bait spray. More promising results were obtained with a bait spray containing 'Clensel,' the use of which cannot, however, be recommended until it has been more thoroughly tested.

The Sunflower—

Concluded from p. 53.

higher proportion of linoleic acid than the oil from the same varieties grown in Africa. This difference, it is considered, is related to the length of the ripening phase; quick maturity in the tropics leads to a higher proportion of saturated acids. Oils with much linoleic acid are valuable for the production of non-yellowing paints and varnishes. In the food industry the absence of linoleic acid coupled with the high percentages of linolenic and oleic acids allows of precise hydrogenation to produce 'shortening' of the required consistency and hardness. In addition, sunflower oil, with or without refining with alkali, can be used as a salad oil or for packing sardines.

Sunflower seed, provided it is decorticated before oil extraction, produces an excellent though hard protein rich cake. Without decortication the many needle-like fibres make handling difficult and the material less digestible to high-class stock.

Erratum

In Editorial Comment in our January issue under the title, 'Colonial Development,' we referred to an addition of £20 million to the funds of the Colonial Development Corporation. The addition was, in fact, to the Colonial Development and Welfare Fund administered by the Colonial Office. In the same Comment, column 2, line 5, for 'futile' please read 'future.'

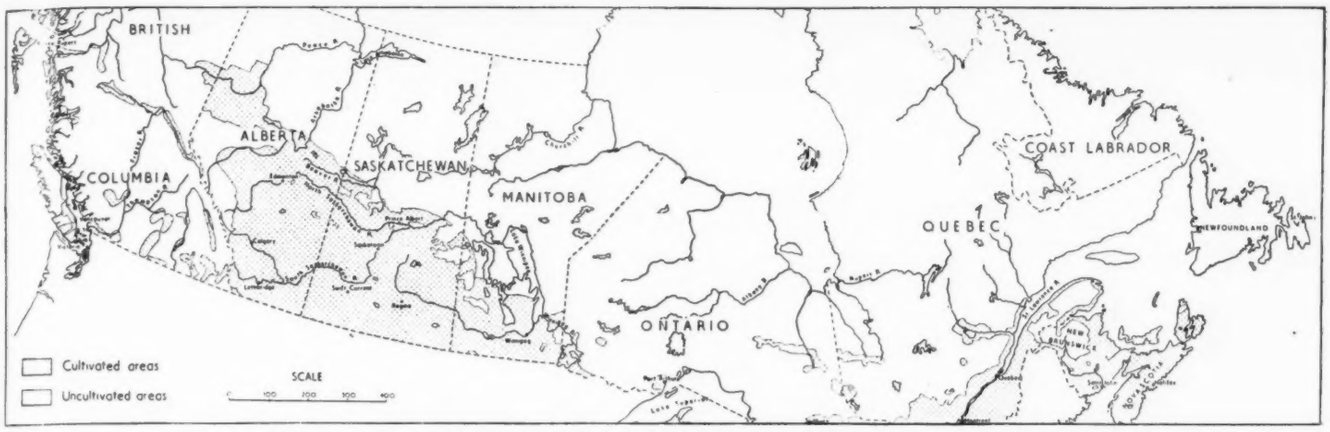


Fig. 1.—The extent of cultivated land in Canada (excluding part of Southern Ontario)

Forage Crops in Canadian Agriculture

R. O. WHYTE, Ph.D., B.Sc.

Grazing problems and pasture management in Canada often assume different aspects from those which they have in countries with less rigorous climates. The following article, reproduced by permission in shortened form from the Journal of the British Grassland Society, provides an account of the present position and a discussion of the salient points as they struck Dr. Whyte during the course of two visits to the Dominion.

IT is possibly not generally realised how little of the land surface of Canada is available for agriculture. An indication of this is given in Fig. 1; of a total land area in Eastern Canada of 600 million acres, only some 128 million acres can be regarded as potential farm land, not too rough in topography or too unfavourable climatically; only 50 million acres in Eastern Canada are occupied at present.

The chief factor influencing the type and utilisation of animal fodder is the climate; a long and in most areas severe winter and a short hot summer characterised by a high expectancy of drought in July and August. Considerable emphasis is therefore placed on fodder for the winter months, on hay crops and silage. Pasture management, in so far as this may be practised, is frequently difficult because of the summer drought, and supplementary crops have to be grown. The resemblance to conditions in the northern European countries (Scandinavia and Finland) is obvious.

The general classification of pastures recommended by the Canadian authorities in their *Farmers' Bulletin* No. 150 in summarised form is as follows:

I. Natural Pastures.
  A. Rangelands—large grazed areas or ranches as opposed to small areas of farm land.
  B. Unimproved grasslands on farms.

II. Improved Pastures.
  A. In the farm rotation.
  B. Permanent improved grassland.

III. Supplemental Pastures.
  Annual crops, hay, hay aftermath, etc., used to supplement natural and improved pastures.

Natural pastures. These are pasture or rangeland which have remained more or less in their natural state and have not been modified by factors other than fencing or some amount of control of grazing. Rangelands are large areas or ranches in Western Canada used exclusively for grazing where the land will not grow wheat or other cultivated crops without irrigation. The mountain ranges are the dry areas used as ranches or rangeland in British Columbia. Submarginal range or pasture lands are tracts of agricultural land in Eastern and Western Canada which have never been used for the production of cultivated crops.

Unimproved grasslands on farms. These include small isolated areas too stony or shallow for mechanised cultivation, or so hilly that erosion and gullying would follow cultivation; tillable land which is not cultivated for some reason, and woodland which is sparsely wooded or covered with stumps or burnt-out forest.

Improved pastures. These are the short-term and long-term pastures which feature in farm rotations, and which may be taken for hay or grazed according to the farmer's needs.

Permanent improved grassland is always under a grass sward except during periodic reseeding or renovation.

Supplemental pastures. These are the pastures or crops, such as annuals, biennials, hay or hay-aftermath, which may be used to supplement the natural improved pasture.

Table I (overleaf), giving the acreage of pasture, improved and natural, compared with hay and grain crops in Canada in 1941, shows a preponderance of the so-called improved pastures in the East, and a great preponderance of natural pastures in the West.

Pasture in Eastern Canada

Although live-stock and dairy farming in Eastern Canada are largely dependent on adequate production and utilisation of forage crops, and although increased attention has recently been given to pasture improvement, the Canadian authorities state that actual yields are at present far below potential production. Pasture is usually the most neglected crop on the average farm and often consists of the roughest and most unproductive land. Yet the results obtained by those farmers who have learnt to appreciate the value of good pasture management indicate the importance of this relatively cheap source of fodder and the need for further studies.

Much work has been done by experimental stations, agricultural institutions, by the fertiliser industry and by private individuals.

Considerable variation occurs in the climate of Eastern Canada, depending upon proximity to the Atlantic Ocean. The average annual precipitation ranges from 43 in. at Charlottetown, P.E.I., to 26 in. at Harrow in south-western Ontario. The rainfall for the growing season, May to September, varies from 18 in. at Lennoxville, P.Q., to 12 in. at Harrow. Frequency of rains shows similar trends.

A considerable amount of soil survey work has been done and much information is available in maps and reports.

In southern Ontario and south-western Quebec the soils are variable, but have largely developed under a humid climate and a deciduous forest vegetation. The grey-brown podsolic soil usually has a thin dark surface layer over a greyish-brown leached layer which rests upon a darker brown layer. Black mud and peat are often found in poorly drained depressed areas. South-eastern Quebec and the three maritime provinces are characterised by podsols. This zone contains leached acid soil which has a distinct, ash-like layer near the surface, and a brown to reddish sub-surface layer. The ash-like leached layer may vary from 1 to 12 in. in depth. These soils are usually less fertile than the grey-brown podsolic soils and may be improved considerably by applications of manure, commercial fertilisers and lime.

Throughout Eastern Canada various species are dominant in the natural pastures. The species dominating Ontario pastures are Kentucky bluegrass (*Poa pratensis*) and to a lesser extent Canada blue (*P. compressa*). Red top and red fescue are most prevalent in Quebec while browntop is more common in the maritime provinces.

Some areas are so rough and stony that they are best allowed to revert to forest, or planted to trees. Others are too rough to permit cultivation, but have sufficient soil on them; certain measures, such as removal of shrubs, stones and weed growth and the limited application of fertilisers and farmyard manure may profitably be used.

A number of factors affect the decision whether to retain permanent pasture on tillable land, or to plough it up for reseeding or incorporation in a crop rotation. Permanent pasture on land which is tillable but inaccessible, has poor drainage, or is affected by labour problems, is better left and treated for maximum production with minimum of expense. The Canadians believe that tillable land may be economically left in permanent pasture where the net revenue from the pasture is greater than would be secured by growing cultivated crops. Even relatively fertile land may be economically used for permanent pasture. It has been until recently in Eastern Canada, and is still in parts of Western Canada, more profitable to secure fresh land for pasture than to attempt extensive improvements.

Sown pastures must produce a heavy crop for grazing, ensiling or haymaking during the short summer. The temporary ley does not have the same length of time as in the more humid parts of England and Wales to produce an economic return on the outlay.

Western range land

The largest area of grazing land in the prairie provinces lies in the drier southern portion of south-eastern Alberta and south-western Saskatchewan which, with the grazing land of the intermountain country of British Columbia, comprise the great ranch country or rangelands of Western Canada. That portion in the Great Plains is approximately 35 million acres in size. It is the area of native short-grass vegetation, a continuation northwards of the short-grass plains of the United States. The true grazing capacity is about 30 acres per animal unit, and the only management which can be given is largely the erection of fences to keep livestock within bounds, the provision of watering facilities and supervision to prevent overgrazing. Some of the land broken for wheat cultivation has become abandoned and reseeded with crested wheatgrass (*Agropyron cristatum*) or smooth brome grass (*Bromus inermis*).

As one proceeds northwards the rainfall increases and evaporation falls, and it becomes possible to sow mixtures of longer duration and higher moisture requirements incorporating lucerne, *Poa pratensis*, red and white clover and similar adapted species.

The problems in the intermountain range country resemble those of the plains, with the addition of forest grazing in the heavily forested country of British Columbia. On the Pacific Coast of British Columbia a maritime climate with much cloudy weather, fog and mild temperatures make it possible to sow and manage pastures according to the practices adopted under humid temperate conditions.

TABLE I—ACREAGE OF PASTURE COMPARED WITH HAY AND GRAIN IN CANADA, 1941

Province	Total Occupied Agricultural Land (Acres)	Cereal Grains (Acres)	Hay (Acres)	Pastures			
				Improved (Acres)	Natural (Acres)	Total (Acres)	Percentage Improved of Total
Prince Edward Island	1,168,863	186,597	228,220	237,062	80,604	317,666	74.63
Nova Scotia	3,816,646	90,974	401,096	175,236	731,801	907,037	19.32
New Brunswick	3,964,109	231,996	562,088	296,776	364,493	661,269	44.88
Quebec	18,062,564	1,989,081	3,756,154	2,519,354	2,090,823	4,610,177	56.65
Ontario	22,387,981	4,732,366	3,712,677	3,237,865	3,879,182	7,117,047	45.49
Total—Eastern Canada	49,400,168	7,231,014	8,660,235	6,466,293	7,146,903	13,613,196	47.50
Manitoba	16,891,322	5,747,432	412,553	455,487	4,823,515	5,279,002	8.63
Saskatchewan	59,960,927	19,120,163	430,417	783,901	19,815,940	20,599,841	3.81
Alberta	43,277,295	11,333,459	602,419	625,578	18,745,520	19,371,098	3.23
British Columbia	4,033,570	215,603	259,617	171,614	1,846,358	2,017,972	8.50
Total—Western Canada	124,163,114	36,416,657	1,705,006	2,036,580	45,231,333	47,267,913	4.31
Total—All Canada	173,563,282	43,647,671	10,365,241	8,502,873	52,378,236	60,881,109	13.97

Beef cattle on an overgrazed range pasture in the short-grass prairie area

Administration of research

In the Canadian Department of Agriculture the Divisions primarily concerned with research and advisory work are the Division of Forage Plants, the Division of Field Husbandry, Soils and Agricultural Engineering, the Division of Animal Husbandry and the Division of Illustration Stations, all within the Experimental Farms Service, and the Divisions of Botany and Plant Pathology, of Entomology and Plant Protection within the Science Service.

To co-ordinate research an Experimental Farm Pasture Committee is being formed, and during 1949 a National Pasture Committee was established, with Dr. T. M. Stevenson as chairman. This committee is engaged in making a survey of pasture research in all provinces of Canada.

Another committee of the Dominion Experimental Farms Service is the Western Forage Crops Committee. This deals with all phases of forage crop and pasture research, including plant breeding, seed production, variety testing, design of experiments and so on.

Work of the Forage Crops Division

This Division conducts plant breeding and collection and production investigations with forage crops. Some highlights from recent work are quoted below.

Grass breeding. Some species not so far used to any extent in Western Canada are now being multiplied for more extensive trials (*Agropyron elonatum, A. glaucum, A. intermedium, A. desertorum, Elymus junceaus, E. Canadensi, E. Virginicus, Poa ampla, Stipa viridula* and *Bouteloua curtipendula*).

Wheat is being crossed with Agropyron with the object of producing a new forage grass with the seed size and quality of wheat, and the perennial habit, winter-hardiness and drought resistance of Agropyron. Hybrid lines produced at Ottawa are stable for most of the morphological characters for which selection was made.

Promising work on these crosses is in progress at the Dominion Laboratory of Cereal Breeding at Winnipeg, where rust-resistant perennial wheats from the cross Chinese × (Chinese × *Agropyron elongatum*) have been produced. Although these breed true they are not sufficiently winter-hardy for Western Canada. They have now been crossed with winter wheat to improve this character.

Legumes. The acreage under alfalfa has increased from 57,000 in 1910 to 1,587,000 in 1945. The first interest in breeding work was to obtain varieties of sufficient hardiness. Grimm was used in Western Canada and Ontario Variegated developed for Eastern Canada. Ladak has been found especially suited to northern areas, because of its heavy yield in the first cut. Viking, developed at Saskatoon, is very winter-hardy and is useful for pasture. For higher seed yields, Canauto was developed at Ottawa and Ferax at the University of Alberta; both these varieties are of Grimm origin. Rhizoma has been developed at the University of British Columbia for grazing, and other grazing types are being evolved at Saskatoon and Swift Current.

The breeding work now combines resistance to bacterial wilt and crown rot with the other objectives, hardiness, hay yield and seed yield.

Sweet clover is regarded as objectionable because of its volunteering habit, a character which is related to its very hard seed coat. Lines with permeable or soft seeds are almost at the distributing stage; the hay yield is slightly less than Arctic or similar varieties.

Ladino white clover is the subject of collaboration between American and Canadian workers. At a conference held at State College, Pennsylvania, in September 1947, it was agreed that improvement in this crop should be directed toward disease resistance, hardiness under varying conditions, and improved seeding habit.

The soybean acreage has been 100,000 for the past three years, but in 1949 the estimated acreage was 120,000; soybeans can be grown in most provinces, and especially in Ontario, southern Quebec and southern Manitoba.

The Division of Forage Crops deals with maize both for husking and for silage; in a few years Canada may be expected to produce her own requirements of grain maize, as a result of the Division's work on hybrid varieties. The hybrid varieties have shown their superiority in yield, strength of stalk, resistance to disease and tolerance of insect pests.

Other crops dealt with are rape-seed for oil, sunflower for oil, and sugar beets. This last crop is also being studied by the British Columbia Sugar Company, which is interested in its development in British Columbia and southern Alberta.

Seed production. Low seed yields have led to a fall in the amount of alsike seed produced in Canada from £18 million to £1 million, 'due to factors still undetermined.' Work is in progress on two phases of the problem; the role of pollinating insects, and the role of nectar. Because of the considerable losses experienced in harvesting alsike seed, straight combining is not recommended; windrow-

ing while the crop is still fairly green is considered desirable, and harvesting with the least possible handling is essential. This does not, however, apply to all parts of Canada, and in Ontario, for example, quite a large amount of alsike seed is harvested direct with the combine.

Pasture investigations

Pastures and other resting breaks. Two trials are in progress at Ottawa, one grazed by sheep and one by beef cattle; both are temporary pastures receiving the same fertiliser treatment as the permanent pasture with which they are compared. The cultivated sheep pasture has consistently outyielded the permanent pasture over a nine-year period, producing 25% more dry matter and 37% more carrying capacity. Although the combined cost of cultural and seed treatments was $6.22 per acre higher on the cultivated pasture, the net return was $2.18 per acre higher. The yields from the area grazed by steers have not been so consistent due to poor drainage and unsatisfactory establishment of seeds mixtures. The main farm rotation at Ottawa is grain, hay, pasture, grain and a hoed crop. At Normandin in Quebec Province a pasture in rotation, over an eight-year period, produced 13% more dry matter than permanent pasture. At St. Anne de la Pocatiére and Lennoxville in Quebec and at Nappan, Nova Scotia, where rainfall is more evenly distributed, evaporation less rapid and soil not so favourable for cultivated species, the improved permanent pasture has been more productive.

The official Canadian conclusion is as follows:

'Where climate and soil conditions favour the production of cultivated crops and where the summer drought period is prolonged, as in Ontario and western Quebec, the cultivated pasture has lengthened the grazing season and provided a greater and more uniform carrying capacity during the whole season. The difference in grazing capacity is even greater during a dry season. Furthermore, where the high cost of land makes intensive cultivation necessary, and where high-priced products such as milk are produced, the higher yielding cultivated pasture would be more economical.'

Crop rotations

The Division of Field Husbandry is interested in crop rotations and farming systems with particular reference to the yields from cereals and other crops in the rotation. In a cash crop area in Essex County, Ontario, for example, maize yields on an old orchard sod were double those from a field continuously cropped to maize and other cash crops. Organic matter contents were 6.2% and 4.4% respectively. In rotation experiments at ten centres, cereals, turnips and potatoes give higher yields after hay or root crops than after cereals, but highest yields after legumes.

The place of forage and pasture crops in rotations in the prairie provinces raises a number of special problems. To the north and west, where the rainfall is adequate and the evaporation is not excessive, pastures and forage crops play their usual role.

Between this favourable zone and the arid range areas of southern Alberta and southern Saskatchewan lie the wheat lands of the prairie provinces, where the wheat/fallow system is practised. Results of extensive work suggest that cropping practices should be based on moisture relationships rather than on systematic rotation.

The Division of Field Husbandry found at Morden, Manitoba, that wheat following wheat gave 12 bushels per acre less than wheat following summer fallow; wheat following sweet clover and maize produced yields slightly higher than wheat following summer fallow. Continuous wheat for 36 years at Lethbridge, Alberta, has produced an average yield of 11.8 bushels per acre. In a rotation of summer fallow/wheat/wheat, the average yield has been 25.2 bushels per acre after summer fallow and 15.8 bushels after wheat, making the average yield per acre for the rotation 13.7 bushels. Dryland rotations containing legumes or receiving manure have not shown any advantage over cereals alone, although, of course, on irrigated land, legumes, manure and fertilisers have given outstanding responses.

It might be assumed that some benefit would be obtained by reseeding to a permanent grass sod resembling the original prairie or range sod before it was ploughed out. It was found at Swift Current, Saskatchewan, that it takes two or more years to obtain a good stand of grass, and it is not considered advisable to include grass in a systematic rotation unless it can be left down for a number of years, given time to develop a good root system and so to improve the crumb structure of the prairie soils. The Soil Research Laboratory at Swift Current has found that, while cultivated prairie soils lost about 20% of their organic matter content under cropping systems whereby the straw is returned to the land, future losses may be negligible provided erosion is prevented.

The overriding significance of moisture in prairie agriculture is shown in Table II which gives moisture data determined to a depth of 5 ft. at the University Farm at Winnipeg in 1929, on heavy clay soils.

Western forage research

Although a great deal of work is in progress in the West, the conditions for which it is done differ so widely from those in any part of Great Britain that only brief reference will be made.

Agronomic data have been collected on recently introduced or developed varieties and species (*Agropyron elongatum*, *A. desertorum*, *A. intermedium*, *Elymus junceus*, *E. virginicus var. submuticus*, southern strains of *Bromus inermis*, and the alfalfa strains, Viking, Ranger, Buffalo, Ferax, Canauto and Rhizoma).

Breeding is in progress on alfalfa for resistance to bacterial wilt, crown rot and black stem; also for development of a creeping rooted strain and of a high seed-producing strain ; and to produce a hardy drought-tolerant creeping root type for dryland hay and pasture use.

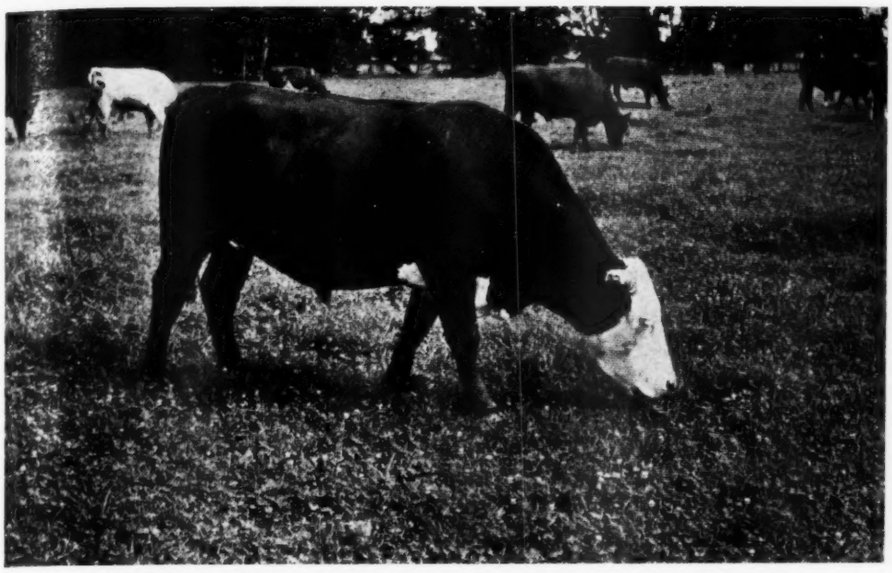
There is a special sub-committee for forage seed production which concerns itself with creeping red fescue for seed production, grass seed production on irrigated land, seed setting trials with *Elymys junceus*, seed production trials in British Columbia with perennial and Italian ryegrass, cocksfoot, *Poa nemoralis*, fescues and other grasses and legumes, and the development of experimental threshers for plant breeding work.

Fodder conservation

As the period of stable feeding in Canada frequently covers six to eight months, the problem of supplying suitable feed for livestock during that period is extremely important. In addition to hay and other roughages, silage is employed very extensively. The chief crops used are maize, sunflowers, sweet clover, red clover, oats, and mixtures of oats and peas. Where maize can be grown satisfactorily, it is the most important silage crop; high yields are obtainable and ensiling is simple. When other crops are used, special care is necessary. Alfalfa, for example, if ensiled at the 10% bloom stage, often produces silage unfit for feed, but when ensiled at the full-bloom stage or in mixture with grasses gives excellent results.

Silage is used very extensively in some provinces, especially in Ontario and parts of Quebec and British Columbia where the type of animal industry demands a high-quality winter feed.

The Department of Agriculture is making a special study of the mechanisation of green crop and hay harvesting. A



A highly productive grass legume pasture in Eastern Canada

Sheep-range on the short-grass plains of Southern Alberta. The sheep are Merino and Rambouillet breeds

TABLE II

	Water Retention Capacity (1-5 ft.)	Available Water Present (1-5 ft.)	Deficit
	Inches	Inches	Inches
Fallow every 2nd year:			
Year 1 fallow	14.70	12.79	1.91
Year 2 wheat	14.92	8.59	6.33
Fallow every 3rd year:			
Year 1 fallow	18.80	14.79	4.01
Year 2 wheat	15.27	9.40	5.87
Year 3 wheat	16.81	9.23	7.58
Fallow every 4th year:			
Year 1 fallow	17.83	14.49	3.34
Year 2 wheat	16.32	9.90	6.42
Year 3 wheat	17.61	9.71	7.90
Year 4 wheat	17.50	9.92	7.58
Rotation:			
1st year fallow	14.28	13.66	0.62
2nd year wheat and seed down	13.65	9.00	4.65
3rd year hay	17.84	7.43	10.41
4th year hay and break ..	17.77	9.79	7.98
5th year wheat	18.62	10.88	7.74
6th year barley	14.62	7.50	7.12

machine known as the Ronning Ensilage Harvester, designed to handle only row crops such as maize or sunflowers, has been operated at the Central Experimental Farm since 1925. Quite a number of farmers have attached loading devices to their maize binders to elevate the maize direct on to the wagon, thus eliminating the heavy work of hand loading in the field.

A more recent development is that of the so-called forage crop harvesters. These are almost all equipped to handle green and dry herbage; by removing the pick-up attachment on the front of the machine, and replacing it with a maize-cutting device, maize can also be harvested. Some machines are equipped with a cutter bar which will cut the legume and grass from the standing crop, and again cut it into short lengths. In other cases, the cutting of the grass and legume is done with a mowing machine first, and the herbage then picked up with the pick-up attachment.

In harvesting hay the field baler is used quite extensively. This eliminates some of the heavy labour of haymaking and conserves space in the barn. Several barn-drying units or barn-finishing units have been installed, but the results have not been promising. Drying in the barn takes too long and only small quantities can be dried at one time. Therefore, the process of haymaking is rather slowed up and disorganised, although the period of drying in the field is reduced. The quality of the finished product has not been improved by barn drying as measured by feeding tests, digestion trials and general appearance.

Comments

1. It is a little difficult for a visitor from a settled country such as the United Kingdom to realise how near to the pioneer days many parts of Canada still are. Saskatoon and Edmonton, for example, are only about 40 years old. In many parts it has until recently been more economic to acquire new land than to attempt to develop fertility-maintaining forms of alternate husbandry or other appropriate farming systems on old land.

2. One does not yet see the same emphasis being given to the grazing animal as an implement of fertility, such as characterises pasture management in Great Britain and New Zealand. Against this one must place the short grazing season during which animals could have this effect, the limited applicability of the grazing ley and the overriding need in Canada to grow crops to be conserved for winter feeding.

A badly over-grazed sheep range pasture in the short-grass plains area of Western Canada

3. Because of the emphasis of high yields for cutting for hay or silage, plant types are almost always hay rather than pasture strains. Strains are compared on the basis of their yields on cutting rather than on the basis of their carrying capacity and persistence under varying intensities of grazing.

4. Breeders in North America tend to be concerned with characters related to disease resistance, winter hardiness and cut yield rather than with growth form and habit.

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'Tropical Agriculture' in a new form

Tropical Agriculture has enjoyed for many years an enviable reputation as an authoritative source of information concerning agriculture in tropical regions, more particularly in its West Indian aspects, and as the official journal of the Imperial College of Tropical Agriculture. It has recently appeared in a new guise, the format of the journal has been reduced in size, the contents have been remodelled and it has been decided to enlarge its scope by including a wider range of topics and by greater insistence on developments outside the West Indies.

During the past few years the journal has been unable to maintain its former regular monthly appearance, owing to paper shortage and other causes and has been forced to appear as an occasional publication.

While we welcome the prospect that in future it will be possible for it to resume regular publication, we cannot but feel some regret at the disappearance of an old familiar friend and at the same time entertain some doubts whether the change is likely to be wholly beneficial.

We are well aware of the partiality of the scientific officer to see the results of his research published in the recognised British scientific journals, but in these rather austere settings the audience which they reach is of necessity restricted while the presentation tends to become more and more scientific and less and less comprehensible to the uninstructed layman who, after all, is the ultimate intended beneficiary of the research; he contributes to its cost and is entitled to be told about it. Long ago the now defunct *West Indian Bulletin and Agricultural News* catered adequately for these needs. This demise left a gap which *Tropical Agriculture* has only partially filled.

The Imperial College is growing rapidly, both in size and scope; it certainly warrants and, in fact, demands that it should be represented by a publication which in form and content adequately upholds its dignity and standing, while at the same time providing readable accounts of the many lines of important work in progress. With all due deference we venture to suggest that in its new guise the publication hardly appears likely to fulfil adequately all these desiderata.

Central America's Food Potential

A vast untapped food reserve in Central America, provided by common weeds and a variety of other edible plants, has been uncovered in a three-year survey conducted by the Nutritional Biochemistry Laboratories of the Massachusetts Institute of Technology, Cambridge, Massachusetts.

937 samples, representing more than 200 kinds of food from plants, were collected in Honduras, Guatemala, El Salvador, Costa Rica, Nicaragua and Panama, and were analysed at the Massachusetts Institute of Technology during the survey, according to a report by Dr. Hazell E. Munsell and five co-workers, which was read at the 117th national meeting of the American Chemical Society.

'The study was undertaken early in 1946,' Dr. Munsell said, explaining that, 'in initiating steps to improve food production in any country it is of first importance to know the potential food value of indigenous edible plants.'

The general procedure called for collection and identification of specimens by a botanist living in each area, and stabilisation of a representative sample of the edible portion for shipment to the Massachusetts Institute of Technology laboratories. The analytical work at the Institute, which was completed early last year, involved a total of 11,951 determinations. Among the plants discovered to contain appreciable amounts of minerals and vitamin precursors were chaya leaves from an ornamental tree found in Honduras, Tampola, which is one of the pigweeds used as a cooked vegetable, cassava leaves, *Jussiaea repens*, which is an aquatic herb from the Rio Tegnarc in Honduras, squash and pumpkin vines, flowers and hearts of the yucca plant. Also included was motate, a shrub found growing abundantly throughout Central America, although used commonly as a food only in El Salvador; it is rich in calcium, as also are the flowers of palms, popular in Gautemala. A troublesome weed in the cultivated areas of that country is the plant *Marva parviflora*, a native of Europe. It has, however, a large content of calcium, iron, carotene, thiamine, riboflavin, niacin and ascorbic acid, indicating that it might be advantageous to make more extensive use of it as food.

Among the Costa Rican plants studied were the growing ends of chayote and yucca flowers. Nineteen samples of beans were analysed and they all had a remarkable similarity in composition. Parsley and Kafir corn or maiz de Guinca were also considered worthy of development.

Seventy-Five Years Young

The Oldest Agricultural Experiment Station in America

C. L. W. SWANSON, Ph.D.

Chief Soil Scientist, Connecticut Agricultural Experiment Station

Seventy-five years young well describes America's oldest agricultural experiment station. Brief as its history is, the Connecticut Station's influence on agriculture in the United States, and even in the world at large, is incalculable. The results of the station's studies and researches on soils, tillage, food crops, fertilisers, forests, and many other phases of agriculture find useful applications everywhere.

LAST year the oldest agricultural experiment station in America celebrated its 75th birthday.

At seventy-five people are old, ready to take it easy, let the younger generation tackle the new problems of the day. Not so for the Connecticut Agricultural Experiment Station. Scientists of the station are continually at work testing new ideas and new methods for the improvement of agriculture.

Birth of the Station

Professor Samuel W. Johnson, founder of the station and pioneer agricultural scientist, gave birth to the idea of agricultural experiment stations shortly after 1850. In 1875 the Connecticut General Assembly passed a law creating the Connecticut Agricultural Experiment Station, the first institution of its kind in America. This marked the beginning of making a 'regular business of discovery' for agriculture — one of Professor Johnson's memorable quotes. As director of the station from 1877 to 1899 he made research the regular business of the station, and discovery its product.

Much has happened in those 75 years. Tremendous strides have been made in agricultural research. Connecticut's example was soon followed by other States, and within 15 years each State had established its own agricultural experiment station. The combined budget of these stations in 1949 totalled 52.5 million dollars. The combined benefit to American agriculture resulting from their efforts is beyond computation.

Early work

Dr. Johnson's first valuable work after establishing the experiment station was the analysis of commercial fertilisers. For years Connecticut farmers had been unmercifully defrauded by unscrupulous dealers who sold 'fertilisers' that were little more than dirt. The publicity given to the station's analyses was relied on as the only means of controlling the quality of the fertilisers sold. This approach had been particularly successful through the years as shown by the 1949 inspection report that 89% of all fertiliser guarantees were met or exceeded.

Director Johnson had a great interest in soils and plants. In his first experiment station report, written with an Edison electric pen, he wrote extensively on the physical and chemical properties of soils. He discussed the reasons for tillage, and emphasised the importance of the falling raindrop in the compaction of the surface soil as a result of the impact of the drop and the clogging of the surface pores by the dispersed silt and clay. It is of interest that nearly 75 years later soil scientists with high-powered cameras and split-second timing apparatus actually took pictures of the action of raindrops and showed Johnson's ideas to be correct. Experimental results of the station's soils department recently corroborated his views. Puddling of the soil surface by hard rains was largely responsible for a 40-bushel reduced corn yield, in contrast to corn cultivated to break the crust. He also wrote about seed testing, analyses of hay, use of peat for crops, analyses of fertilisers, etc.

Johnson—the author

In addition to being director of the station, Johnson was also professor of agricultural chemistry at Yale University. Before the station was organised he wrote two books, one entitled *How Crops Grow —A Treatise on the Chemical Composition, Structure and Life of the Plant* and another called *How Crops Feed—A Treatise on the Atmosphere and the Soil as Related to the Nutrition of Agricultural Plants.* The first was published in 1868 and the second in 1870. Several editions of each appeared and they were translated into several languages. Sir John Russell, the famous

Stream-lined spraying of experimental plots, arranged in spirals, at Connecticut Station

director of the Rothamsted Agricultural Experiment Station, the oldest agricultural experiment station in the world, used these books as source material for the writing of his authoritative book *Soil Conditions and Plant Growth*, first published in 1912.

Space limits going into detail on the many and varied discoveries obtained by research techniques at the Connecticut Station for the betterment of agriculture, not only for Connecticut and the United States but for the world itself. Only a couple of the research finds will be elaborated on here.

Research triumphs

One famous and comparatively well-known example is the work of Dr. D. F. Jones in the development of the first 'double cross' method of producing hybrid seed corn. In one generation, hybrid corn spread across the continent like wildfire, once it was made commercially available in the 'thirties.

With an estimated increase in yield of 20% for the United States, use of the higher corn yielder helped conservation of the land, too. More could be produced on fewer acres and the poorer land retired to grass and tree crops, and more of the land in row crops rotated with grasses and legumes. Soil erosion could be better controlled and fertility of the land increased. It has been estimated that over 12 million additional acres of open-pollinated varieties would have been needed to produce as much corn as the 67 million acres planted to hybrid corn in 1949. The additional yearly value of this corn crop is estimated at close to a billion dollars.

The late Dr. M. F. Morgan's work on soil testing is another notable piece of research. He was the first individual to make soil testing practical, so that many soils could be tested quickly, easily, and cheaply. He found a chemical solution that stimulated the action of plants in taking up nutrients from the soil. Morgan devised a series of tests to include all of the major and secondary nutrients required for good plant growth. Results from his tests showed which kind of fertilisers should be used and how much, thereby eliminating waste of fertilisers and also insuring larger crop yields. Today his test procedures or modifications of them are used extensively in the United States and in many foreign countries. It has been estimated that the worth of his tests amount to a million dollars annually in Connecticut alone.

Seed testing, spraying to control plant disease and insects, soil science, tobacco culture, forestry, studies in protein chemistry, early studies in chick nutrition, fertiliser inspection—those and many other problems of agriculture have engaged the expert attention of the station scientists. Publication of some 20 bulletins a year by the station, writings of the staff in scientific journals, press releases, and a twice-yearly issued popular account of the station's findings in *Frontiers of Plant Science* keep Connecticut citizens and scientists world-wide informed of the research products of the station.

It is well, too, that research has been done on agriculture. Think for a moment what might have happened if Johnson's idea of research 'for the use of farming' had died in infancy. Those who now loudly propound the 150-year-old Malthusian principle would have *real* cause for alarm. They wouldn't have to excoriate agriculture. The *people* would be so food-short they would be clamouring for action.

If research in agriculture had not been started by Prof. Johnson, there would surely have been less to eat for the people of today. China, with little research activity in agriculture and many people, is a living example.

Population growth provides a realistic approach. It is said that 800,000 Indians inhabited the 1,905 million acres of these United States when the first settlers set foot on our shores some 350 years ago. The first 200 years after the white man arrived the population increased only to about 4 million people. By 1850 it had grown to 23 million, by 1900 it was 76 million, and in 1950 it is estimated that the population is about 150 million. For the year 2000 one population expert estimates that the population will be 186 million.

Had not scientists like Dr. D. F. Jones of this station conducted tests and investigations for the improvement of agriculture, less food would be produced and available today.

(From 'The Science Counselor,' Duquesne University Press, Pittsburgh, September 1950.)

Oil Co's New Film

A new film entitled 'Farm Review,' made by the Anglo-American Oil Co., was shown for the first time at Earls Court, London, during the Smithfield Show. It is a 'short,' covering various aspects of farming activities, including an interesting sequence taken at the Royal Agricultural Society's forage harvesting trials held last year. Other items covered include the pre-emergence spraying of sugar beet with vaporising oil and a short sequence on last year's hop harvest.

Speeding the Plough

A paper entitled 'The Effect of Speed on Ploughing' was read at a recent meeting of the Association of British Agricultural Engineers by Professor Ewen McEwen, professor of agricultural engineering at King's College, Newcastle.

The paper dealt with the results so far obtained from a series of experiments carried out during the last three years on six different locations, using five standard Ransome plough bodies, the object being to determine the effect of speed on ploughing.

From the results obtained it was evident that there was no significant difference in the net increase of draught, corresponding to an increase of speed from two to four miles per hour, for any of the five plough bodies used. Quality of the work done, also, did not significantly improve or deteriorate with varying speeds. In studying the effect of weed control, the full digger type body was found to control weeds the least and the number of weeds found growing after this plough was found to be more than twice as great as those for the semi-digger and medium general purpose bodies. Prof. McEwen suggested that the reason for this might be the big crevices left by the full digger which would enable air to get to the semi-buried weeds.

From the experiments carried out so far it was concluded that 'there is no inherent difficulty in ploughing at four and a half miles an hour even with the existing plough designs, and that the increase in draught at higher speeds is justified by better pulverisation of the soil.'

After the paper Lord Radnor, proposing a vote of thanks, suggested that plough design might be radically altered if agricultural engineers experimented with more varied shaped designs of implements for doing the work of the plough, and it may be that the ideal machine for ploughing at increased speed will not look anything like the conventional plough. Dr. E. W. Russell, who seconded the vote of thanks, said that it didn't matter what speed was used; the draught would be the same. The important thing was to keep fuel consumption per acre constant while at the same time increasing speed or acres per hour. He considered that the criterion of quality in ploughing was the efficiency of burying obtained.

In the discussion that followed several points of interest were raised, including the suggestion that the scouring effect of various mouldboard designs might be worth investigating.

Sorghum Breeding in the Sudan

S. H. EVELYN, A.I.C.T.A,
Senior Cotton Breeder, Empire Cotton Growing Corporation

An article in 'World Crops' of last April gave some account of the millets, of which sorghum is the most important. In the U.S.A. it is widely grown as a forage crop and as a source of sugar. It is also, however, the staple food of millions of people in Africa and Asia. Considerable work has been done in the U.S.A. on the improvement of sorghum as a forage and sugar crop, but little has so far been published about its amelioration as a food grain for human consumption. This article gives a general account of the genus and of investigations on its improvement as a human food grain by selection and breeding carried out, mainly by the author, in the Anglo-Egyptian Sudan.

SORGHUM is cultivated for various purposes throughout the arid and semi-arid parts of the world under a host of synonyms. It is called Kaoliang in China and Manchuria, Juar or Jawari in India, Kaffir Corn in South Africa, Dura or Dhurra in the Sudan, Egypt and the Middle East, Broom Corn in Italy, Guinea Corn or Imphee in the British West Indies, Millet in the United States of America and by different names in the native languages of various African and other tribes as, for example, Mapira in the Bantu language of Central Africa.

In China, India, parts of Africa and the Middle East, it is grown mainly for the grain for human food and drink and for the stalk and leaves as animal fodder. It constitutes approximately 90% of the food of the Sudanese. In the United States it is cultivated for its grain as an animal food, or as fodder (Sudan Grass) or for syrup manufacture, but not for human consumption. This exclusive use of it for animals or syrup creates a difficulty in that grain colour and palatability are not considered in the breeding programme and, as a result, few of the excellent varieties produced in the United States find favour in the Sudan and other countries because of the very conservative food tastes of the inhabitants. In West, Central, East and South Africa and in the British West Indies, sorghum is grown mainly as a subsidiary human food and to a lesser degree as a cattle fodder, though in many parts of Africa, especially in the drier areas, it would be a more suitable crop than maize. In many of the above places the sweet-stemmed varieties are chewed by the natives as an additional form of sugar and the dried stalks of many varieties are often used for building and fencing.

Two compact 'late' maturing types from Tanganyika, held up by the Author

Origin

There is evidence that sorghum was grown in Egypt as early as 2200 B.C., and the wealth of forms to be found in the Sudan suggests that it must have been cultivated for a very long time. It is generally agreed that, as the wild forms exist almost exclusively in Africa, this continent must be the home of origin, although at least one wild form, *S. halepense*, Pers., is indigenous to both Africa and India, suggesting an origin prior to the land bridges of Pleistocene times (1948).

In the course of his study of the crop, the author found that in the Sudan, certain characters such as head-shape, compactness, grain-size and to a lesser extent maturation period, were almost exclusively zonal, except in the central Kordofan Province. The table at the bottom of the page illustrates the zoning of these characters in the provinces of the Sudan.

With the exception of the Kordofan Province and certain areas such as Khor el Adar (Upper Nile Province) and Khor Abu Farazha (Kassala Province), wild forms are relatively scarce or occur as out-crosses with commercial types. In the Kordofan Province they are abundant in their pure state or as out-crosses with the cultivated forms. In the Sudan, the wild sorghums, closely related to Dura, are collectively known as 'Adar.' Further, in the collection of 640 varieties (approximately 450 from the Sudan and the remainder from India, South Africa, East Africa, the Belgian Congo, Somaliland, Abyssinia, Eritrea, Egypt, Cyprus, Italy

ZONAL CHARACTERS OF SORGHUM IN THE PROVINCES OF THE SUDAN

Northern Province (NNW)	Kassala Province (NNE)	Darfur Province (WC)	Khartoum Province Blue Nile Province (EC)	Kordofan Province (C)	Upper Nile Province (SE)	Equatoria Province (S)
90% Club V/Compact Big Grain Early-Med 10% Spindle F/Compact Med/Grain Early	95% Club V/Compact Big Grain Medium 5% Spindle F/Compact Med/Grain Early/Med	100% Spindle F/Open Med/Grain Med/Late	95% Spindle F/Compact Med/Grain Early 5% Club V/Compact Big/Grain Medium	All Head Shapes Compactness Grain-Sizes Early/Med and Late	95% as in Darfur 5% Grass-Heads V/Open Med/Small Late	95% Grass-Heads V/Open Small Grain Late/V. Late V/Tall 5% Spindle F/Compact Small/Grain Medium

Grain size in the above table is classed as big, medium and small. Maturation is classed as early, medium and late.

and the United States), it was noted that all importations and local types had their counterpart represented in the Kordofan collection, including even the transitional forms between commercial varieties and Broom Corn, which were obtained from the Belgian Congo. It also appeared from visits to other parts of Africa and from the literature, that only in the Kordofan Province is there this amazing diversity of types, ranging from the wild forms with hairy glumes and with seeds either partially or completely enclosed, through all the transitional forms of head-shape, seed-extrusion, grain-size and colour, dwarfness to tallness, pithy to sweet-stemmed, leaf and stem sizes, early to very late maturity and even varieties with two fertile flowers in each spikelet. These all appeared to be relatively happy under the same environment.

For the above reasons it is suggested that the Kordofan Province of the Sudan is the home of origin of the sorghum genus.

The genus

Many generic names have been given the sorghums. Hackel placed all the cultivated ones and the various forms of the perennial Johnson Grass in one botanical species. Piper stated that two species exist—the perennials such as Johnson Grass and its varieties (*Andropogon halepensis*) and the annuals (*Andropogon sorghum*). Snowdon in his classification of the grain sorghums of the Sudan, placed them into 11 different species and subdivided these into many varieties and the varieties into several forms.

In the course of his investigations, the author found that the Johnson Grass types (2n = 40 chromosomes) crossed fairly easily with the annual types (2n = 20 chromosomes) and further evidence of this is seen in stands of Sudan Grass (2n = 20 chromosomes), in which the perennial habit is frequently to be observed. It was also found that the annual types, both wild and cultivated, and including the Broom Corns and the syrup Sorghos, crossed very readily and produced fully fertile hybrids.

From these data it was concluded that all the cultivated sorghums belong to one species, of which Johnson Grass is just a diploid variety. It is therefore suggested that the old name, *Sorghum vulgare* (C. H. Persoon, 1805), be adopted to include all the sorghums and differentiation between them should be on a purely varietal basis.

Selection work (1940-1946)

In the years 1919-38, Massey, Bailey, Kenchington, Punter, Knight *et al.*, carried out work on the sorghum crop in the Sudan, but this consisted mainly in the introduction of varieties from the United States and the testing of these against a collection of the best local strains from various parts of the country. Knight tackled yield improvement by selection for seed-size, but it was later proved by the author that seed-weight is a very stable genetic character. It was not until 1940 that a comprehensive survey of the varieties of the whole country was undertaken and a definite breeding programme formulated.

In 1946, the collection numbered 640 strains, 450 of which were local. It is considered that a further 200 strains are still to be found in the Sudan, but the inaccessibility and difficulty of transport in a country with an area of 967,500 square miles, coupled with the fact that this work was purely subsidiary to the cotton-breeding work, precluded a more intensive search being made in the remoter areas.

The collection was grown in adjacent rows at the Gezira Research Farm under irrigation, and the following characters were recorded: germinability; striga susceptibility; leaf mid-rib colour; type of straw; stem sweetness; tillering and suckering; panicle emergence; stem width; plant height; stem-borer (*Sesamia cretica Led.*) susceptibility; plant erectness; panicle shape; midge (*Contarinia sorghicola Coq.*) susceptibility; common smut (*Sphaceolotheca spp.*) susceptibility; head shape; head compactness; peduncle shape; awn-ness; tolerance to wind; bird susceptibility; Andat bug (*Agnoscelis versicolor F.*) susceptibility; self-compatibility and crossability; days to mature; yield of head, grain and straw (green and dry); threshability; threshing percentage; grain colour (Ridgeway's colour standards); weight of 100 seeds; store-pests susceptibility; seed moisture content; seed nitrogen content; grain palatability (cooking and brewing tests by cross-section of native staff); grain value (by Government assessors).

Variety trials

All promising material from the type plot was sent out to the provincial agricultural stations, to blocks of the Sudan Plantations Syndicate and to others for testing against their local varieties in demonstration or replicated trials. The results were analysed by the author and in this way selection of the most suitable strains for each area was accomplished.

The Blue Nile, Kordofan and Kassala Provinces, at that time, produced 80% of the total grain yield and, as the former is regarded as the granary of the country, they were given first priority in the breeding programme. In the Blue Nile Province the variety Dwarf White Milo showed such yield superiority to the generally cultivated Feteritas, particularly in the irrigated area, that in 1943 5-acre random plots of it were compared with the local strains of Feterita at each of the 39 blocks of the Sudan Plantations syndicate. Simultaneously, three comprehensive replicated variety trials were sited in the north, centre and south of the Syndicate concession. A significant mean grain increase of 18% in favour of Dwarf White Milo was obtained in the block trials and 25% in the variety trials. The former figure computed on the then price of the two varieties for the Syndicate's annual irrigated area of 120,000 acres would have increased the grain value of the crop by £E177,350. In addition, Dwarf White Milo is resistant to the forms of

Early maturing (dwarf) sorghum ex-U.S.A. from Tanganyika

common smut which occur in the Gezira and would thus render less necessary the anti-smut treatment of seed with copper carbonate; it is also less damaged by birds than the Feteritas and matures about a fortnight earlier and would thus save one complete irrigation. It was assessed at 3/6 higher than Feterita per ardeb of 336 lb., and eating tests showed it to be slightly superior. Its nitrogen content was the same as Feterita.

In the Kordofan Province, where sorghum is mainly rain-grown and a mixture of a host of early-, medium- and late-maturing varieties, it is generally cultivated as a safeguard against a rain failure at any period of the growing season. The problem of improvement was tackled in a different

Late maturing sorghum, Uganda

way. First, 120 local and other strains were grown at selected sites and the poorest of these, in each maturation group, were discarded until workable numbers remained. These were then tested in replicated trials and the three best of each maturation group were selected for each of the main sorghum areas. This took about four years and the selections were then bulked and distributed to chosen growers.

In Kassala Province, in the flood-irrigated areas of the Gash and Tokar deltas, trials very soon showed the superiority of Aklamoi White over all comers, and this variety is now exclusively grown. It is very popular, of excellent commercial value and the depth of grain on its very compact head precludes a complete failure of the crop in bad locust years. In the Gedaref district of Kassala Province, a

Late maturing Uganda types

mechanised crop-production scheme was recently started and many of the best of the 'combine' dwarf and double-dwarf varieties from the United States, together with suitable types from the type plot, were made available for testing. In 1944, work was also conducted in the Tessenei district of Eritrea during that country's administration by the British Military Administration.

Trials in other parts of the Sudan, although giving valuable data, were not so conclusive, mainly because of pre-occupation with more important matters during the war. Conflicting results prevented final selections from being made in these areas, though in Equatoria Province, however, an introduction from Uganda and Moru—a local variety—gave outstanding yields in the Kagelu and Maridi districts.

Unfortunately, pressure of cotton work made it necessary to discontinue the sorghum breeding in 1946 and it was therefore impossible to bring the varietal problems of the whole country to a successful conclusion.

Other facts of interest

Striga hermonthica Benth. In collaboration with Dr. F. W. Andrews, a large number of varieties were pot-cultured in soil infected with Striga seed. This root parasite germinated with equal facility on all varieties. In variety field trials, however, without deliberate infection, it was noted that Dwarf Hegari and Dwarf White Milo withstood Striga attacks better than the Feteritas.

Leaf mid-rib colour. Green mid-ribs indicate juicy and generally sweet stems. White mid-ribs are associated with pithy and unsweetened stems. In the Sudan this is important, as sorghum is the main animal food. In this connection slender stems are more readily eaten by animals than thick stems.

Panicle emergence. This is genetic. Partial emergence results in the loss of all grain which remains enclosed in the leaf sheath. Such varieties as Abu Kudur and the Wad Akers are to be avoided, for although often very heavy yielding, their inability to completely extrude their panicles results in losses of as much as 20 to 30% of the grain.

Midge susceptibility. In the Gezira, mono-stemmed early-maturing varieties are less attacked by midge than strains which tiller and sucker freely or are late-maturing. Many varieties in the type plot showed high resistance.

Leaf width. The Kurgi variety of the Kordofan and Upper Nile Provinces has the widest leaf of all sorghums encountered. It is claimed that locusts will not eat it nor will cattle.

Common smut susceptibility. In collaboration with Dr. S. A. Boughey, all varietal seed was infected with spores of the four forms of common smut which occur in the Gezira, and sown under conditions most suitable for smut production. The Milos showed immunity to all forms and many other varieties displayed either immunity or high resistance.

Bird susceptibility. A large number of varieties were purposely grown near trees and damage from birds was recorded. Grain colour and presence of awns made no apparent difference. Dwarf White Milo showed the least damage and this is attributed to the strong adherence of its seed to the glume case and possibly also to the fact that this variety is goose-necked

and so birds can only attack its grain in an inverted position.

Self-compatability and crossability. Most varieties displayed strong self-compatability and bagging did not affect seed setting or reduce yield. Varieties varied widely in their response to natural crossing. Dwarf White Milo, with 19% vicinism, gave the highest value.

Grain colour, size and nitrogen content. In collaboration with Mr. O. W. Snow, an analysis of nitrogen content of all varieties showed no association with colour but only with grain size. This result is of interest, in view of the strong medical prejudice against the growing of white-grained sorghums, although these are generally bigger grained than the cultivated coloured varieties.

Storage pests. Heads and grain suffer heavy losses in storage from the beetle *Rhizopertha dominica* F., the weevil *Sitophilus oryzae* L., the moths *Sitotroga cerealella* Oliv., *Ephestia kuhniella* Zell., and *Corcyra cephelonica* Staint., and secondary pests such as *Tribolium confusum* Duv. The claim that the late-maturing small-seeded varieties of Equatoria Province are resistant to storage pests was not substantiated. None of the vast number of varieties observed was outstanding in this respect. Colour, moisture content or bitterness of grain appeared to make no difference. To maintain the type collection, heads were dipped in a solution of mercuric protochloride and mercuric iodide, but this treatment was ineffective. Reducing the seed moisture content from about 10% to below 1% was also ineffective, as on exposure the seed regained its former moisture. Paradichlorbenzene was completely effective in preserving head specimens in cases, but it had to be frequently renewed. Gammexane was also completely effective for tinned or bagged seed and apparently does not affect viability.

Two very distinct 'late' maturing types of sorghum from Tanganyika. In particular the marked contrast between the 'closed' and 'open' heads should be noticed

(Photos in this article supplied by the Author.)

ACKNOWLEDGMENTS

The collaboration with the author of British and Sudanese colleagues at the Gezira Research Farm, the staffs of the Agricultural Department and Sudan Plantations Syndicate and others who helped in this work is gratefully acknowledged.

The author is particularly indebted to Dr. R. L. Knight, of the Empire Cotton Growing Corporation, Shambat, Sudan, for suggesting certain amendments to the sections on Origin and Genus, which have been incorporated.

East African Agricultural Research

The recently published report* of the East African Agriculture and Forestry Research Organisation reveals the difficulties attendant upon building up a comprehensive organisation which will be responsible for the general conduct of longer range agricultural and forestry research and will replace, eventually, the Agricultural Research Institute at Amani in Tanganyika. The report covers the period ended March 31, 1949, and is thus somewhat out of date; if the forecasts contained in it are verified, much more substantial progress will have been recorded by the end of the corresponding period in 1951.

During the greater part of the year under review part of the administration was centred at Nairobi and part at Amani, and the gradual transfer of certain branches to Nairobi had been accomplished by the end of the year. Amani, however, continued to remain the only centre for laboratory research. Some progress was recorded in the erection of the headquarters and laboratories at the new site at Muguga, near Nairobi, but it is obvious that a considerable period must still elapse before they can completely replace Amani.

Despite difficulties, substantial progress is claimed in research. The reports of the five sections of the organisation and of the schemes closely associated with the organisation are, however, so brief that it is somewhat difficult to assess this progress at its true value. The associated teams concerned are the fertiliser experiments team, shortly to be absorbed in the organisation, the clove research scheme in Zanzibar, the scientific supervision of which is the Director's responsibility, and smaller schemes for meteorological studies and survey of arthropod fauna of soils. In addition, the Director has assumed responsibility for administering the research scheme for Colonial termite investigations, so long as the team is working in East Africa.

The Report includes brief accounts of research on virus diseases of cassava, groundnuts and maize, and of diseases of cloves in Zanzibar. The clove research scheme, Zanzibar, has so far been unable completely to establish that 'Sudden Death' disease is caused by a virus, although there are strong indications that it is. Work has commenced on problems of forest mycology. In the plant physiology section studies have been made on the uptake of nitrogen and phosphorus by maize in sand culture. Soil fertiliser investigations have been continued by the fertiliser team with the co-operation of other workers. Conclusions from this work are premature until full results are published, together with data concerning the soils on the experimental areas. The section of soil chemistry reports on methods of fractionating soil phosphates and finds some indication of a relation between the absorbed phosphate in the soil and response to phosphate applications. This section has also commenced the study of oxidation-reduction potentials in soils which may lead to developments in relation to the cultivation of rice and possibly other crops.

Finally, attention is drawn to the investigations on climatic data in relation to agriculture, and the work of the newly created statistical research section. The examination of meteorological data with a view to delimiting agricultural zones is a line of study which should eventually produce striking results, while the recent creation of a statistical section must be considered timely.

The organisation and the scheme in the West Indies are the first two of the projects for development of agricultural research in the Colonial Dependencies on a regional basis, sponsored by the Colonial Agricultural Research Committee and in part financed from Colonial research funds. The experience gained should prove of great value in connection with similar projects in other Colonial regions. D. H. G.

*East African High Commission, East African Agriculture and Forestry Research Organisation Annual Report, 1949. Pp. 44. Obtainable from Secretary, P.O. Box 601, Nairobi, $2/50 (E.A. currency).

The Improvement of Hand Tools for Tropical Agriculture

G. B. MASEFIELD, M.A., A.I.C.T.A.
Department of Agriculture, University of Oxford

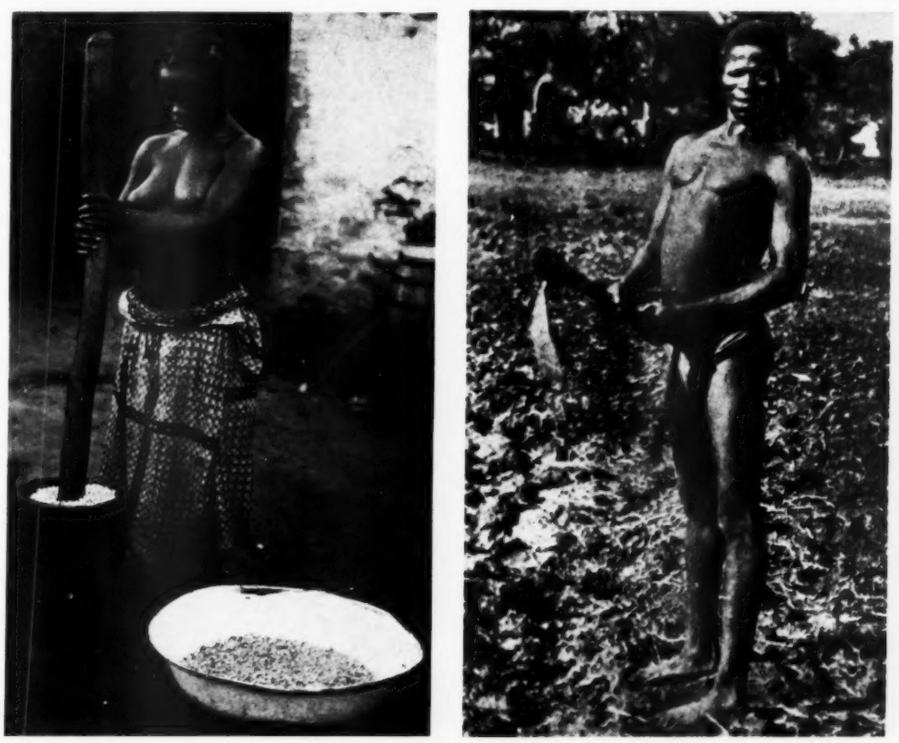
Much has been written about the possibility of mechanising smallholding agriculture in the tropics; in this article the author points out the primitive and inefficient character of most of the hand tools used by the tropical peasant cultivator and suggests that if more effective forms could be introduced great economy of effort and improved efficiency would result.

IT is extraordinary how little attention has been given to improving the hand tools used in tropical agriculture. Amongst the strident (but often uninformed) clamour for rapid mechanisation, the small voice of pleas for the investigation of the pitifully inadequate tools of the peasant has had little chance of being heard. Yet these tools will be with us for a long time yet.

The hoe

The hoe is the most universal of tropical implements. A fraction of a foot-pound of energy saved on every stroke of the hoe would save more tropical labour than mechanisation is likely to achieve in our lifetime. Such improvements might come about through better metallurgy or better design. Of the former it seems that, for various technical reasons, there is little immediate chance in the countries manufacturing hoes for export. The situation is different in countries that still supply their own requirements. In Nigeria, little or no native ore is now smelted, and the smithing industry is apparently entirely dependent on scrap which is bought, or very often stolen, from railway workshops and similar places. This metal is hardly likely to be ideal, still less of uniform quality, for the making of hoe-blades. Here there must certainly be room for improvement.

In the field of design, tropical peoples cling so closely to traditional patterns for hoes that a leading British exporting firm has to figure no less than 157 different shapes of hoe-blade in its catalogue, and most of these are offered in several different weights. The number is much increased by adding the variations made by local smiths in many parts of the tropics, which include such extraordinary forms as the two-handled hoe of the Nigerian Birom, or the perforated hoe, also in Nigeria, which is locally known as a 'hand-plough' but might more aptly be called the 'fish-slice' hoe. Now, even allowing for the need of variation for different kinds of soil and forms of cultivation, it is obvious that with this rigidity of local custom many tropical farmers are using implements which are too clumsy, too light, or too heavy for the job they are doing. Apart from this, a reduction in the number of types sold would mean more mass production and cheaper hoes all round. Yet what research is being done to discover what is the most economical shape, or weight, or length of handle, for the hoe in use on the job?



(*Left*) **Pestle and mortars of this primitive type are used extensively by African natives and also throughout the tropics for hulling cereals and for a variety of other purposes.** (*Right*) **A Nigerian native farmer preparing his soil for cultivation with the local type of short-handled hoe**

The problem of inertia

The inertia to be overcome on both sides is massive. The peasant goes regularly back to buy a hoe which, he at least knows, works; and often has little idea that any other form of cultivating implement has been evolved anywhere in the world. The interest of the manufacturer—whether factory manager or local smith—is to continue to supply the article which is in demand rather than to risk money in trying to change the market's tastes. He may even be tempted not to manufacture a better hoe with a longer life because it

will reduce the turnover of his sales. The only agency which can break this circle is perhaps a government Department of Agriculture, which has both the knowledge of conditions under which the implements must be used and the ability to explain these to the manufacturer. Little, however, has so far been done in this direction.

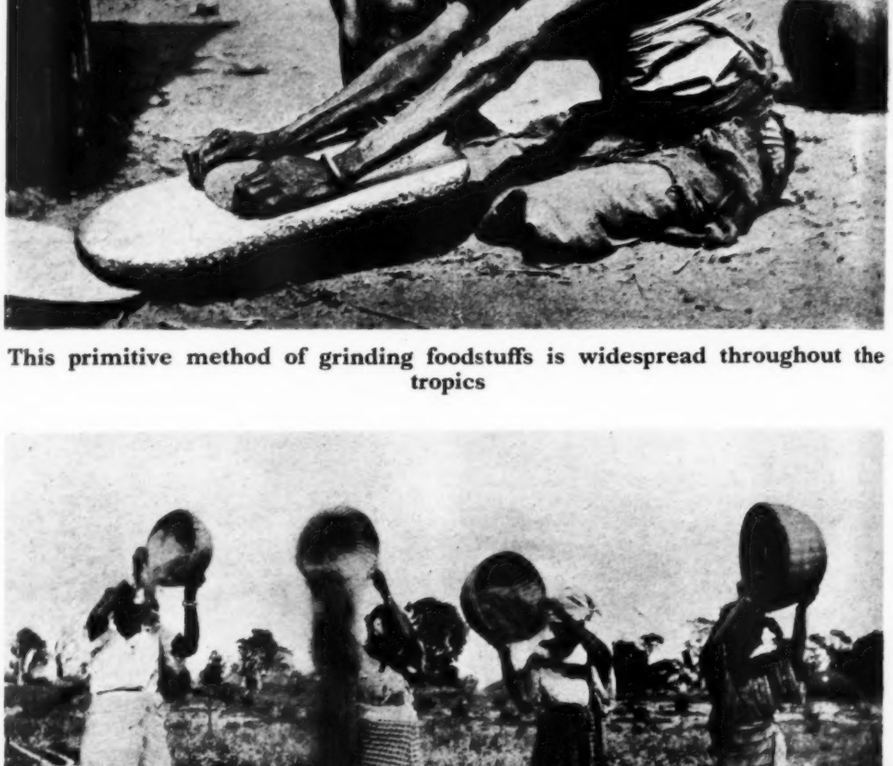
Need for data

At present, all concerned are often ignorant of the most elementary data. A hoe manufacturer quoted to me as one reason for not attempting to make more durable hoes, his firm's opinion that most hoes ended their life by being lost rather than worn out. This is not my own impression at all; I would say that most hoes are worn down and perform their last service in the hands of children who could not wield the heavier unworn blade. But the point I wish to make is that nobody has investigated this elementary question, which could be settled by a survey carried out in one or two villages by an Assistant Agricultural Officer.

The pestle-and-mortar

Almost as common as the hoe in tropical Africa is the pestle-and-mortar, used for pounding or grinding grain or root crops. Here again interesting variations occur. In East Africa only the single-ended pestle is known. In many parts of West Africa a double-ended pestle is used, the two ends being differently shaped so as to deal with different materials or produce meal of differing grades of fineness. This is a much heavier instrument. Now either the single-ended pestle must save effort, or the double-ended, or each has its uses for different operations; but the point is that nobody has investigated which of these three suppositions is correct, and the two implements continue to be used in different regions from habit, and without any rational basis.

This primitive method of grinding foodstuffs is widespread throughout the tropics



Winnowing groundnuts in Gambia by allowing the wind to separate hulls from kernels. The method is also used for many other products including cereals, notably rice

Palm nut cracking

An incredible amount of labour must be wasted each year on the millions of palm nuts cracked to extract the kernels by Nigerian women who place them upon one stone and hammer them with another. A stone is at best an awkward and clumsy mallet, even if the stones used were all of the ideal weight to accomplish the job with the least muscular effort, which manifestly they are not. In one home I visited, however, I saw a woman using a short iron bar for this work and obviously cracking nuts faster and with less effort than the others. Now the Nigerian Agricultural Department has evidently given thought to this matter, for it has encouraged the introduction of nut-cracking machines, though the number of these is still infinitesimally small. Yet it may be questioned whether the substitution of the iron bar for the stone would not have saved more labour over the same period. It is by neglect of such small means that much labour is still wasted; while it may also be borne in mind that to the peasant the change from the stone to the iron bar may represent an intellectual advance as great and as stimulating as the substitution of the plough for the hoe.

Vegetable peeling

In other cases, it is not only labour but valuable material that is wasted. In most tropical countries, peeling of vegetables is done with crudely-fashioned local knives which take far too thick a peel. In some tests made with Uganda women, it was found that 42% by weight of sweet potatoes and 41% of cassava roots were removed on peeling. Although small quantities of these peelings may be fed to stock, they must represent an annual loss of many thousands of tons of human food which the world can ill afford. Much of this loss could be avoided by the use of a simple potato-peeler such as is found in English kitchens, which has a guard to prevent too thick a peel being taken. It is true that the cost of these little implements when imported into tropical coun-

tries may be too high to attract the native buyer; but they may be a profitable investment in the end, or local manufacture or subsidisation may be worth considering.

The possibilities

The possibilities of saving labour by the introduction of manual tools used in other countries are almost endless. One might even go backwards in history and suggest that the flail, which has long gone out in England, would be a boon in those countries where several sorts of grain are threshed with sticks, which are much less efficient implements for the purpose. Then again, everyone who has lived in tropical Africa has noticed the never-ending task of trying to keep grass short in government stations by the use of crude slashers made out of baling-iron. Having myself tried, and failed, to induce African labourers to use (*a*) the bent cutlass of the West Indies, and (*b*) the one-handed Norwegian scythe, I am not foolish enough to think that such a revolution can be accomplished quickly or easily; but surely the effort should be persevered with. It seems odd that in groundnut-growing countries the ordinary garden fork has not been tried for harvesting, for it appears a much more suitable tool than the hoe and might soon repay its cost in the greater percentage of nuts recovered. There seem also to have been few or no experiments in trying out small wheeled push-hoes of the ' Planet Junior ' type; the modern instrument with its range of attachments is a most versatile tool, and should be able to find some place, at least in tropical countries with a light sandy soil like Nigeria.

This, however, brings us up against the fact that the tropical peasant does not possess the same physical strength as the British labourer. This consideration is known to the old-established exporters of hand tools and has been brought home to them by experiences of the past. In the countries of south-eastern Asia liberated in 1945, it was necessary for some time to supply hoes of lower weight than that market was accustomed to demand, because the people were too underfed to be able to use a heavier implement. But this factor of low physical strength does not yet seem to have been considered by those manufacturers of horticultural tractors and motor scythes who aspire to sell their products in the tropics. Complaints from drivers of these machines have been numerous.

A veil of scientific ignorance still surrounds the whole question of the design and functions of the simpler tools of tropical agriculture.

(Photos: Imperial Institute, London.)

NEW BOOKS

Soil Conditions and Plant Growth

By Sir E. John Russell. Pp. xvi & 635. Illustrated. Longmans, Green and Co., London, 1950, 35s.

Sir John Russell's ' Soil Conditions and Plant Growth ' has long been recognised as a classic, and perhaps one might almost say *the* classic book on soil science. Since it first appeared in 1912 it has run through seven editions, the last of which appeared in 1937. Each successive edition has been extensively revised to bring the information contained in it up to date and to include new advances in knowledge and the appearance of a new edition is therefore always an event of some note.

In this particular case it is of special interest inasmuch as since the last edition there have been many noteworthy additions to existing knowledge, while on this occasion great changes in the manner of presentation have been made. With the exception of Chapter I, which remains virtually unaltered, the whole book has been almost entirely rewritten, the number of chapters has been increased, their form recast, and the illustrations greatly augmented. It is thus in many respects a new work, although the aim has been to keep to the original framework.

For this revision Dr. E. W. Russell, Reader in Soil Science at Oxford University and son of the original author, is responsible. One can at once agree that the task has been carried out with judgment and efficiency, while the admirable clarity of expression and simplicity of statement which distinguished the earlier editions have been well maintained. Consequently, the book remains one which, although it embodies the results of much recent research and as such is invaluable to the student and the research worker, can still be read with pleasure and profit by the general reader equipped with only a modicum of scientific knowledge.

Where all is so excellent it is perhaps invidious to single out particular passages for praise or criticism, but the series of chapters dealing respectively with soil structure, the biological populations of the soil, the decomposition of plant material, soil organic matter and the nitrogen cycle, struck the reviewer as particularly good. It is, however, perhaps a little surprising that no mention is apparently included in the chapter relating to soil nitrogen, of Pearsall's work on oxidation-reduction potential in waterlogged soils and its application in practice to manuring rice soils.

The final three chapters are devoted to principles of soil management, cultivation and fertility maintenance. They include, among other things, an excellent, though necessarily condensed, account of soil erosion and the principles governing its control; perhaps here more emphasis might have been laid upon the variability of erosion incidence with climatic conditions.

Some five pages in this section relate to tropical soils. In this connection the considerable differences which exist between the soils of humid and superhumid tropical regions and those of subhumid and semi-arid regions might have been stressed. In particular, under the former conditions the importance of the highly active surface soil layer and under the latter the beneficial effects which have been found to follow periods of bare fallow might have been mentioned.

These, however, are minor matters and the book as a whole in its new form worthily upholds the tradition established by earlier editions. It is, as usual, well documented and its value is enhanced by the numerous new illustrations admirably chosen and excellently reproduced. It should find a place on the bookshelves of all interested in the great subject of soil fertility upon which in the last resort the continuance of the human race depends.

H. T.

Plant Viruses and Virus Diseases

By F. C. Bawden. Pp. 335. Chronica Botanica. Wm Dawson, London, 3rd Ed., 1950, 48s.

This new edition of Mr. Bawden's book is most timely. Attention is being focused on the necessity for increasing the world's food supply to keep pace with its increasing population, while in many countries virus diseases are reducing the yields of important food crops. The mild mosaic which infects practically all commercial potato stocks causes a loss estimated by Mr. Bawden at 200,000 tons a year in Britain alone. The losses from cassava mosaic in tropical Africa must greatly exceed this figure. An annual loss of well over 50,000 tons of cacao in West Africa is only a beginning if the virus diseases are not controlled. Peach and cherry viruses are taking serious toll in the United States and Canada. Losses occur in both sugar crops, from sugar beet yellows as

much as 20% of the crop, and from sugar cane mosaic. One can omit many virus diseases and add only citrus decline, groundnut rosette, maize streak and wheat mosaic to make it clear that hardly any important food crop is unaffected.

The cost of virus diseases is far greater than the value of the lost crop. Control measures which keep the diseases at their present level and prevent still heavier losses are expensive. Mr. Bawden points out that the severe virus diseases of potato are avoided at an annual cost of over £5,000,000. Before the disease is brought under control the fight against swollen shoot of cacao will cost several million pounds in operational costs and compensation to growers.

It is one of the merits of this book that this kind of information is included as well as such purely technical aspects as 'Chemical and Physical Properties of Purified Virus Preparations' (Chapter 10). The reader with a general interest in plant viruses may find heavy going in this and the chapters on Serological Reactions of Plant Viruses, Quantitative Methods of Assaying for Viruses, The Purification of Viruses, The Crystallinity of Plant Viruses, The Estimation of Particle Sizes, and Types of Inactivation. The book is so well written, however, that he will follow the author with interest and without difficulty through the Introduction and the chapters on Symptoms of Infected Plants, Methods of Transmission, The Relations between Viruses and Their Vectors, Mutations, Interference between Strains, Recovery from Disease, Taxonomy of Viruses, Virus Diseases and Host Plant Physiology, Control Measures against Virus Diseases, and Speculations on the Origins of Viruses.

In this last chapter the author is considering the possible origins of the virus particles, not of virus diseases. The origin of many apparently new virus diseases is quite clearly in another host. Cucumber mosaic virus, for instance, frequently increases its host range and causes a new disease in another species of plant. The comparatively new and still increasing virus diseases of cacao in West Africa are almost certainly due to viruses which existed in the indigenous flora long before cacao was introduced from South America. There is evidence that new diseases also arise through mutation-like changes in the viruses themselves, giving rise to strains of greater or lesser virulence than the parent virus.

Those concerned with the application of research findings to agriculture or horticulture will probably turn first to the chapter on control measures. It is still true that all practicable control measures are preventive in principle. By destroying infected plants, either in the crop or other hosts among the weeds and local vegetation, the spread of viruses to healthy plants can be reduced. The use of healthy planting material is an obvious precaution not always taken and indeed often impossible when symptoms are masked, unless there is an organisation for the testing and propagation of special virus-free stocks. Much can be done to reduce the spread of viruses by intelligent planning of plantings, rotation of crops and insect control, but once the disease has appeared it is important that the grower should think of the field as the unit to be 'cured,' not the plant, by surgical treatment sacrificing the individual plants which are infected. The successful treatment of infected plants on a commercial scale is still beyond us.

This book is invaluable to virus research workers, but one hopes it will reach a wider audience. Both author and publishers are to be congratulated.

A. F. POSNETTE.

Principles of Silviculture

By Frederick S. Baker. Pp. 414. McGraw Hill Book Co., London, 1950, 42s. 6d.

This book might perhaps have better been called 'The Foundations of Silviculture' since so much of it deals with the influences affecting the growth of trees and upon which the operations of silviculture are based.

The whole field of these influences is very thoroughly surveyed and in considerable detail. From the point of view of the forester in the field the author may appear to try too much to find a numerical expression or graph for the various processes of growth of the tree or of the development of woods, especially as we find fairly often repeated such phrases as 'it is doubtful whether the . . . factor is important to the forest.'

The examples illustrating the arguments are naturally drawn from American forests with perhaps too much emphasis on the conifers, but in view of the great importance of softwoods in the timber trade more data have been collected for them than for the hardwoods.

The author starts from the form and composition of the forests and their classification and proceeds through the nutrition of the tree to its measurable growth. The exposition is clear although occasionally the foreign reader will find himself held up by the use of terms which are special to American forestry. Thus 'intermediate' is applied to tolerance or the degree to which a tree can endure shade and to trees according to their position in the canopy, *i.e.* to those corresponding to 'dominated' in English parlance.

The foreign reader is likely to get the impression that the author does not consider that plantations are or can be forests, for there are only very brief references to them. Such a sweeping statement as that in Chapter 6, on the Water Supply of the Forest, that forests cannot be profitably irrigated, would be strongly contested by Indian foresters; the Canal Plantations of the Punjab must be some of the most profitable forests in the world. The final section of this chapter might with advantage have treated the control of soil moisture through silviculture at greater length as in most of the dry parts of the world it is a subject of the first importance.

Chapter 7 on the Utilisation of Water by the Forest is one of the most interesting in the book, shattering many of the theories on which the now older generation of European foresters was brought up.

In the chapters dealing with the growth of trees and the problems of increment the aspect is rather too restricted to American, or at any rate to temperate forests for such a statement as 'the problems of silviculture deal almost entirely with understocked stands' cannot be said to apply to much of tropical forestry. Also it is hardly fair to restrict silviculture to forests which have suffered at the hands of man or of nature.

In making these criticisms one must always take account of the public to which it is addressed and, considered as a whole, one can confidently recommend the book to students starting to learn silviculture and needing a clear exposition of the scientific bases of that difficult art.

W. A. ROBERTSON

New Publications

The following books recently published, which are of interest to readers of WORLD CROPS, are available from the Book Department, WORLD CROPS, Leonard Hill Ltd., 17 Stratford Place, London, W.1:—

Servicing and Maintaining Farm Tractors, by E. J. Johnson and A. H. Hollenberg. Illustrated. Pp. 313. McGraw Hill, 25s. 6d.

The World Outlook and State of Food and Agriculture, United Nations publication. His Majesty's Stationery Office, 7s.

The How, Why and When of Diseases and Insect Control in Your Garden, by Westcott. Illustrated. Pp. 231. Lippincott, 24s.

Land Utilisation in Indonesia

The problem of the improvement of the agriculture of native populations in tropical lands is of world wide importance. It presents differences in different geographical and ethnographical settings, but there are many broad general similarities common to all aspects. The following account of the problem as it presents itself today in Indonesia has been condensed from an article, recently published in Java, by Ir. J. H. de Haan, Chief of the Indonesian Bureau for Land Utilisation.

THE Bureau of Land Utilisation in Indonesia was established in 1948. Its task is to formulate measures whereby soil fertility will be preserved, water supplies safeguarded, erosion and devastation prevented and the highest possible agricultural productivity achieved.

It may be regarded as a national planning organisation which subjects the land to technical as well as economic and social investigation. It starts from the soil as the basis of production, since the soil is the factor of primary basic importance and together with water comprise the fundamental resources. The first aim o the organisation is therefore to bring these natural resources to the highest possible level of productivity and to maintain them thereat.

Economic and social conditions may vary; they must, however, be adjusted to the natural conditions and potentialities of the land and they should be developed so as to ensure that the agricultural methods employed conduce to proper land usage and high productivity.

It should be realised that welfare planning includes aims beyond those of increasing production and the efficient utilisation of natural resources. It also covers social and cultural matters such as public health, nutrition, social amenities and recreation.

Within this frame lies the field of activity of the Bureau of Land Utilisation. Its first aim is to preserve natural resources and to improve agricultural production, but its activities are designed to fit in with plans for rural development in other directions, the ultimate aim being a well balanced agrarian system.

General conditions in Indonesia

As in other tropical countries, rural production in Indonesia is far below its optimum. Technically, it is undoubtedly possible to raise production, but the guarantee for the success of improvements is to be found in their adjustment to the economic structure and the social conditions in the areas concerned. In the application of scientifically tested agricultural measures, sociological and social-economic investigations are of great significance. One of the primary causes of the present unsatisfactory situation is the extremely rapid increase in population with which the development of agricultural measures and of economic and social conditions could not keep pace. During the period 1860-1940 the population of Java increased from 12 million to nearly 48 million inhabitants. Before the war the density of the population amounted to 360 inhabitants per km. (940 per square mile), or, if the area taken up by forest reservations is excluded, to 480 inhabitants per km. (1,250 per square mile).

Transplanting paddy seedlings in a roadside paddy-field, Java

The rapid increase in population resulted not only in the reduction of the size of the farms to an average of slightly over 1 hectare (2.47 acres), but also in inefficient farming and soil depletion.

Before the war Java was just self-supporting as regards rice production, but as a consequence of the small area of the farming units and correspondingly small yield per hectare, diet was very poor, especially in proteins. Next to production deficiency came the growing danger of rapidly spreading soil erosion.

The problems in the other islands of the extensive Indonesian Archipelago, for example, shifting cultivation, ranching and uncontrolled burning of grasslands and forests have different aspects, but result in the same evils of soil depletion and low production.

Drawbacks of the small scale farm

We have already seen that in Java there are too many farms and consequently the farms are too small. Farming on this extremely small scale has two distinct disadvantages. In the first place practically the entire area has to be used for growing foodcrops which to a large extent are consumed by the farmer and his family, and hardly any land is left for cash crops. The farms, therefore, are poor in capital and this implies that there are insufficient means for buying fertilisers, better farming equipment and the application of efficient farming methods.

Secondly, small-size farms can utilise only part of the labour supplied by the family and this gives rise to idleness and inefficient work, and the productivity is consequently low; 60% of the population consists of native farmers producing as little as 40% of the national income. It is certainly possible for a smaller number of larger farms to attain higher production and in this connection lowering of population pressure by emigration to other parts and industrialisation merit and are receiving special attention.

Pre-war and post-war conditions

Before the war the agrarian division of Java came up to a fairly high standard. Nearly one-fourth of the area, 23.5%, was delimited as protection or production forests, so that the steepest terrains, which

form important watersheds, were effectively protected against erosion. Another 7·5% was taken up by estates, on which as a rule soil conservation was fully assured. Indonesian peasants used 60% of the land, 25% as irrigated rice-fields, and 35% as gardens and non-irrigated fields. The remaining 9% was not in use or was taken up by houses, roads, etc.

There were, however, some weak spots, for although the Indonesian cultivator carefully and efficiently cultivated his irrigated rice-fields his treatment of the non-irrigated lands was often extremely reckless. As a result 30 to 40% of the land area of Java was more or less seriously eroded.

Since the outbreak of war in 1941 the agrarian position in Java has seriously deteriorated, particularly in the forest reserves where some hundreds of thousands of hectares of forest were felled. Moreover, considerable areas of estates cultivated in permanent crops such as rubber and tea were partly or entirely ruined.

Pre-war conservation work

It was found that effective propaganda could achieve good results and by making appeals to surplus labour in the villages the Agricultural Extension Service succeeded in getting conservation work carried out over extensive areas. As an example may be cited 17,000 hectares in West Java which were completely terraced and protected in the course of five years. When it is added that in this part of Java the average peasant only possesses about half a hectare of dry fields in addition to his irrigated rice lands, it becomes clear that in the course of a few years some tens of thousands of cultivators must have been enlisted in the fight against erosion. The figure becomes even more striking when it is realised that on very steep slopes terracing, including the building of stone walls, necessitates 400 to 500 man-days per hectare.

Social effects of soil conservation

Terracing and similar work can serve purposes beyond those of soil conservation, and open up wider perspectives for agricultural improvement and better farm management. They facilitate, for example, the use of organic manures and enable cattle to be more effectively utilised. Owing to the enhanced fertility economic crops give higher yields, thus affording opportunities for the introduction of capital and stimulating co-operation, *e.g.* in the purchase of artificial fertilisers. Conservation measures in fact do not stand as a separate and distinct effort, but integrate themselves into the farming

Hillside terracing in Java

system and can help to place general farming methods on a higher plane.

Characteristics of Indonesian peasantry

Moreover, the Indonesian peasant is not naturally an individualist; he is essentially a part of a village community in which social tendencies are highly developed and where there is usually a strong internal organisation. Full advantage is being taken of this in efforts to organise soil conservation work and other schemes for agricultural betterment in Indonesia.

As a further example of what can be done, conditions in the island of Bali may be cited, where societies for the co-operative management of irrigation and other matters of rural betterment exist. Before the war an appeal was made to these organisations to co-operate in protecting the lower slopes of the volcano 'Ajung' where large irrigated tracts were in danger of being overwhelmed with sand and silt brought down from the deeply incised ravines on the upper slopes. The work was beyond the capacity of individual cultivators and even of individual village communities, but by establishing an organisation in which all the villages concerned took part it was found possible to carry out the measures required. In five years 20,000 hectares of ravines were demarcated and protected by planting with bamboos and fruit trees, the whole work being done on a voluntary basis by the combined efforts of the village communities, which in addition, voluntarily undertook to maintain them and keep them in good repair.

Bureau of Land Utilisation

These examples indicate the great significance of the village organisations as centres for initiating rural development, and accordingly they form an essential part of existing programmes. Developments are viewed integrally and as a whole, and it is held that all measures which contribute to welfare of a village or a community must be correlated and support one another mutually. Clearly development must be based upon the education of the various social strata of the community to appreciate the benefits, and equally clearly individual developments must not lead to any loosening of pre-existing social ties and linkages, the value of which have been so abundantly proved. These principles underlie the work of the Bureau of Land Utilisation which is actively furthering the establishment of regional welfare committees, in which experts in various fields participate, and which are given a certain semi-official status. They cover all phases of developmental activity and within the framework so provided agricultural development finds its appropriate place.

Conclusion

It is obvious that if welfare development is to be organised successfully a concrete basic programme is needed. This is more especially important since under existing conditions sufficient expert advice cannot always be available to deal with all the local problems. Accordingly, the only workable basis is the formulation of regional plans, and in doing this the Bureau of Land Utilisation plays an important part.

The first need is the classification and summarisation of existing data and its supplementing by additional surveys to provide basic information regarding the whole country. This can be embodied into maps and statistical tables on the basis of which plans are drafted in accordance with the general framework of rural development. This plan is actually being followed and an effort is being made to provide an organisation which matches the task, notwithstanding the shortages of technical staff. At present utilisation plans are being compiled for North Sumatra and Celebes and in the near future for South Celebes also.

It should, however, be borne in mind that apart from the immediate problems of rehabilitation arising out of the war, the post-war period confronts an entirely new set of problems. Freshly formed ideas

have come to the front and these are liable to make themselves forcibly heard. As a result of war and post-war occurrences the attitude and outlook of the people have substantially changed, new expectations have been aroused, which clamour for fulfilment, and activities have been started which must be led into peaceful channels if development is to succeed. Before the war the village communities were traditionally peace-loving and well balanced and in existing conditions they demand special attention.

APPENDIX

The following shows the successive steps laid down in the working scheme for Rural Planning Committees and Land Utilisation Services in Indonesia:

1. The establishment of a Rural Planning Committee (R.P.C.) in every province subordinate to the Provincial Government.*

2. The assumption by the R.P.C. of its task of promoting development by directing and executing plans.

3. The provision of a technical Land Utilisation Section by the Central Land Utilisation Bureau.

4. The drawing up of a programme of urgent needs by the R.P.C., followed by preliminary investigations by the L.U.S. on the basis of which the R.P.C. orders the compilation of a definite plan with time-table and budget.

*R.P.C.s comprise a president representing the local government, a secretary who is the head of the L.U.S., and representatives of the various services integrated into rural planning.

(Photos: Indonesian Information Service.)

Christmas Acknowledgments

During Christmas and New Year we have received numerous cards and calendars from associates and friends. To them and many others throughout the world we wish a peaceful and prosperous 1951.

Calendars were received from Albright & Wilson Ltd., and Monsanto Chemicals, while Messrs. May & Baker Ltd. thoughtfully sent us a copy of the Gardeners' Diary. Cards were received from the following: Aveling-Barford Ltd., Batchelor & Co. (Ireland), Bolijn (Holland), George Cohen & Co., Colonial Development Corporation, Fina Petroleum Products, Glaxo Laboratories Ltd., D. P. Hopkins, Esq., Imperial Chemical Industries, Mackay Industrial Equipment, Marshall, Sons & Co., The Murphy Chemical Co., National Institute of Agricultural Engineering, New Holland Machine Co. (U.S.A.), Jack Olding & Co., Pest Control Ltd., 'reader' Romano (Istanbul), Rotary Hoes Ltd., Scottish Mechanical Light Industries.

Wastage of Vegetables During Distribution

A. G. THOMSON

The losses which occur in perishable fruit and vegetables during storage and transit are considerable; if they could be reduced or eliminated both consumers and producers would benefit. The factors conditioning these losses are discussed below.

EVERY year large quantities of fruit and vegetables are wasted because of deterioration which takes place during storage and distribution. These losses are among the factors responsible for the very wide margin between the price the grower receives for his produce and the price the consumer pays. Any reduction of this form of wastage should therefore assist in bringing down living costs, while additional tonnages reaching consumers in good condition would represent a valuable gain to countries such as Britain, where the high level of agricultural production is making heavy demands on the soil.

This aspect of distribution is being systematically studied in Great Britain, where scientific investigations are throwing valuable light on the causes of deterioration, thus gradually enabling the technical efficiency of distribution to be improved. Britain's approach to this difficult problem is a happy example of co-operation between Government Departments at the scientific level, for the work is being undertaken by the Department of Scientific and Industrial Research in close association with the technical and scientific staffs of the Ministries of Food and Agriculture.

While the investigations are concerned specifically with storage and distribution in the United Kingdom, the knowledge gained should be of great value to other countries where similar conditions exist, since wastage occurs wherever vegetables are produced and marketed on an extensive scale.

The distribution of fruit and vegetables covers such a wide field that initially research has to be confined to a few selected crops. The investigation involves finding out exactly what happens to the produce under existing conditions of distribution and what technical improvements can be effected in storage and handling methods.

In this instance it is not wastage during the growing period that is of primary concern, but the loss of quantity or quality which occurs after the crops have been harvested. Freezing is also outside the scope of the investigation, for freezing kills vegetables. The marketing of fresh fruit and vegetables involves the handling of a product which is alive, and the problem is to prolong its life as much as possible.

Basic requirements

It was clear from the outset that a knowledge of national marketing methods was required, and fortunately there were certain channels already in existence through which much of the necessary information could be obtained. Valuable assistance was forthcoming from the Ministry of Food (Fresh Fruit and Vegetables Division), which has officers stationed in various parts of Britain. The National Agricultural Advisory Service through its county officers was also able to provide information regarding such aspects of the investigation as the packing and handling of crops.

In considering the distribution of a crop such as lettuce, one of the first requirements was to devise some dependable means of assessing such qualitative factors as wilting or shrivelling, so that a large number of observers, whether working together or separately, could have a common language with which to describe the results of their observations. A numerical system for expressing deterioration has therefore to be devised and this very difficult problem has not yet been fully solved.

Fundamental to all problems of wastage during distribution are time, temperature, and the deterioration resulting from these two factors. There are, of course, various other factors which influence deterioration, such as conditions of harvesting, damage during packing and transit, etc., but these must all be studied against the fundamental background of time and temperature.

Age and deterioration

Since fruits and vegetables are living organisms, they begin to age as soon as they are deprived of their source of

nourishment, and progressive deterioration occurs. Once fresh produce has been removed from the soil it is only a question of time before it has completely rotted. That period is influenced very radically by temperature, the higher the temperature the more rapid being the process of deterioration. Hence ageing can be retarded by refrigeration.

There are limits, depending on temperature, to the length of time that can be allowed before freshly cut vegetables such as lettuces reach the consumer's table. Since there are various recognisable stages in distribution, it was necessary to ascertain the time limits between these stages, such as from cutting on the farm to loading onto a lorry or railway waggon (transit time), from unloading at railhead to arrival at the wholesale market, from wholesaler to retailer, etc. Samples have been taken at various points to determine the temperature of the vegetable itself in comparison with the prevailing air temperature.

Self heating

Throughout their journey to the market vegetables, being living organisms, are giving out carbon dioxide and taking in oxygen, and during this process heat is produced. It is possible, therefore, that when a large stack of fruit or vegetables is sent to market with ' field heat ' present, the phenomenon of self-heating may occur. This happens when the heat produced by the crop cannot escape and the temperature therefore rises. As happens in a wet hayrick, the greater the rise in temperature the more rapidly heat is produced. The primary purpose of these temperature measurements was therefore to find out whether any self-heating does occur.

Besides ascertaining whether, under existing conditions of handling, heating occurs at any stage of distribution, it is important to ascertain how much loss of moisture takes place, this being another very serious factor. Excessive loss of moisture from vegetables such as broccoli and lettuce can render them much less valuable for human consumption. Wilting is, of course, related to the moisture loss, which can be measured by the loss in weight.

By finding out what happens during actual marketing practice it is possible to ascertain the effect of the time and temperature complex on the vegetables, so that within certain limits improvements in handling can be recommended.

Staying power

Generally fruits or vegetables which have been stored lack what might be termed the ' staying power ' of the freshly cut produce. Even at low storage temperatures they slowly lose some of their vitality, so that the time available for marketing is shortened. It is important, therefore, to know how long produce can be kept under the best conditions of storage and still be marketed in good condition.

For example, the knowledge already gained has made it possible to predict the scope and limitations of refrigerated storage for broccoli. A warm spell in spring may bring on the crop so rapidly that the market is congested. It might be a valuable gain to producers and distributors—and also to the country—if some of the crop could be withheld from the market until the glut was over.

Another aspect of the investigations concerns the possibility of improving the conditions under which vegetables are handled both during transit and while they are actually on the market. The advantages of moisture-proof wrapping are at present being examined and attention is also being devoted to the use of crushed ice for keeping vegetables cool and moist in transit.

Broccoli and cauliflowers have both been very thoroughly studied and a considerable amount is known about these two vegetables. It has been found that gas storage gives a slightly longer keeping period than the usual refrigerated storage. Some Kentish growers have found it very useful when the broccoli crop matures all at the same time during a period of warm weather, to keep part of the crop in the empty gas stores normally used for apples until the market has improved. There is, of course, a limit to the time that the crop can safely be held back, the maximum period under the best conditions being about three weeks at a temperature of 32°-34°F.

The storage of carrots is not at present of great importance, but this problem received considerable attention during the war. In the light of existing knowledge advice can be given to people wishing to store carrots in refrigerated stores. This practice has been adopted by certain canners, who require to have stocks available up to the end of March and sometimes experience difficulty in fulfilling their requirements at that period, particularly after a hard winter. A temperature of 34°F. inhibits sprouting and enables good quality carrots to be kept in satisfactory condition for this purpose.

The problem of storing lettuce is under investigation. Though prolonged storage is not possible, growers often find it useful to hold lettuce back from the market for four to seven days, which is at present the maximum period under the best conditions. The best results are obtained by storing at a temperature of 32°-34°F.

Other crops under investigation include peas, runner beans, tomatoes and celery. Not much research has so far been done on peas or runner beans, but growers have already been able to hold their crops from the market for short periods during gluts.

Tomatoes are difficult to store, because they are intolerant of low temperatures and, in fact, cannot be kept at temperatures under 53°F. Some means of extending the life of this fruit is still being sought.

Agriculturalists Honoured

Among the New Year Honours List appear the names of the following for services connected with agriculture, to whom WORLD CROPS tenders its respectful felicitations:—

BARONS

Archibald Crawford, former Chairman, Leicester Farmers' Union, and Chairman of Crawford, Prince and Johnson, Ltd.

Thomas Macpherson, Farmer and Labour M.P. for Romford 1945-50.

KNIGHTS BACHELOR

Thomas Dalling, Chief Veterinary Officer, Ministry of Agriculture.

R. W. Haddon, C.B.E., Chairman, Ministry of Agriculture Publicity Committee, Editor of *Farmer and Stockbreeder*.

C.B.

C. T. Houghton, Under-Secretary, Ministry of Agriculture.

C.M.G.

W. J. Hall, Director of Commonwealth Institute of Entomology.

J. C. Muir, Member for Agriculture and Natural Resources, Tanganyika.

H. J. Page, Principal of the Imperial College of Tropical Agriculture, Trinidad.

C.B.E.

T. C. Brash, for services to the Dairy and Fruit Industries.

Major C. R. Dudgeon, Chief Food Officer for Scotland, Ministry of Food.

W. H. Guillebaud, Deputy Director-General, Forestry Commission.

R. W. Horton, late Chairman, Wiltshire A.E.C.

G. H. Russell, for service in Angus and Kincardine.

J. S. Scouler, Director of Dried Fruits and Edible Nuts Division, Ministry of Food.

V. B. Wigglesworth, Director of Unit of Insect Physiology, Agricultural Research Council.

O.B.E.

H. S. Barnes, Principal, Ministry of Agriculture.

J. R. Bond, Principal, Broomfield Farm Institute, Derbyshire.

A. H. Clarke, late Principal, Ministry of Agriculture.

A. Dryburgh, Chairman, Central Farmers Limited, Fife.

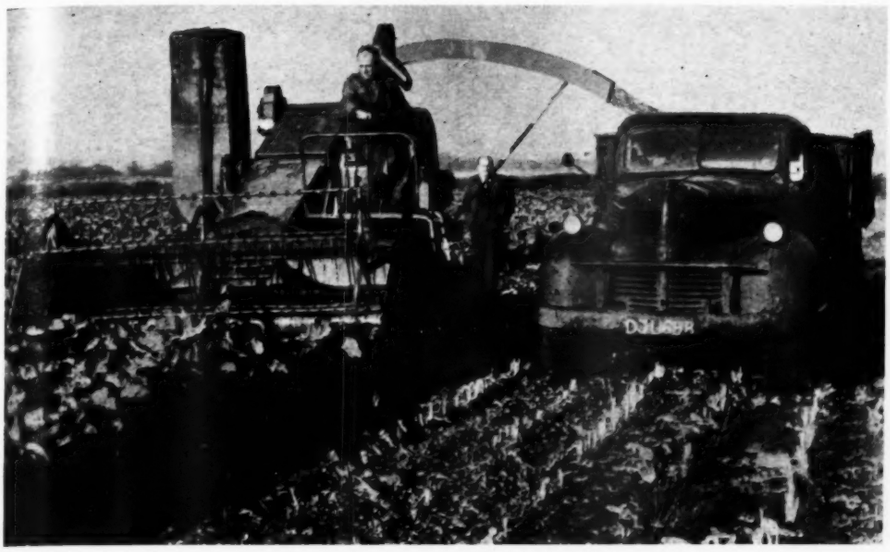
D. Morley Fletcher, Senior Director of Colonial Development Corporation, West Africa.

W. S. Kelly, Agriculturalist in Australia.

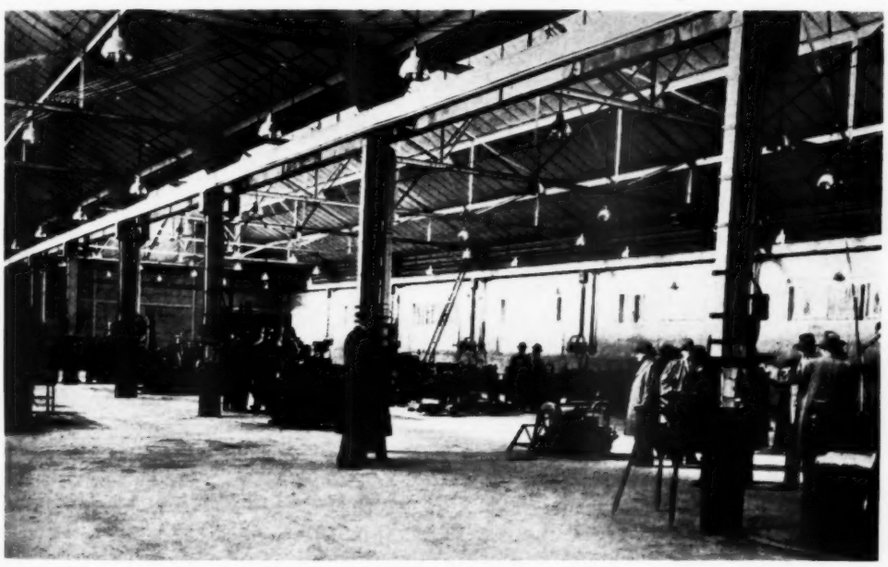
L. Lord, Assistant Agricultural Adviser, Colonial Office.

R. L. Payne, Assistant Director, Fresh Fruit and Vegetables Division, Ministry of Food.

FARM MACHINERY



The M.C.95 forage harvester conversion cutting kale



Part of the St. Dizier tractor plant operated by International Harvester's French subsidiary, Compagnie Internationale des Machines Agricoles. Installation of machine tools was still going on when this photo was taken

French Tractor Production Increasing 30%

The first McCormick Deering International Farmall ' C ' tractor was produced at St. Dizier in the Haute-Marne province (N.E.) of France last October, less than four months after ECA had approved the manufacture of tractors by International Harvester's affiliated company in France, Compagnie International des Machines Agricoles (CIMA).

At present only 20% of the unit is manufactured locally, but it is planned that the tractor will be a 100% ' made in France ' product with an ultimate goal of 7,500 units produced annually. This will step up national tractor production by 30%. During inaugural ceremonies and inspection of the first tractors, Mr. R. P. Messenger, executive vice-president of the parent company in Chicago, pointed out that while St. Dizier works would not be expected to produce Farmall ' Cs ' as cheaply as those made in the United States, the French-made model will be sold to the farmers of France for less than an American-made tractor can be imported.

CIMA is reponsible for IH sales in North Africa as well as France.

Harvesting Forage Crops by Combine

The combine harvester can now be worked throughout the year by cutting forage crops as well as corn with the aid of an attachment designed by Mitchell, Colman and Co. This forage harvester attachment, as it is called, is being adapted for use with all the leading makes of combine harvester; production has begun on the model for the self-propelled Massey-Harris 726 combine.

The work of conversion entails no permanent alteration to the original machine and the following is a brief description of the operation:

1. A cutter bar is fitted to the unit in front of the existing cutter bar, covering the latter with a prefabricated casing.

2. The beater unit and concave are removed and there is substituted a specially-constructed ' Robust ' chopper running on the ball-bearings used for the beaters.

3. The straw-walkers are covered up and a plate fitted which is agitated by the straw-walker mechanism.

4. The blower unit is fitted at the straw outlet and a belt fitted to drive the impeller.

5. The attachment can be provided with a molasses tank. Chopped fodder can thus be fed into the lorry or trailer already mixed with molasses for silage.

6. The attachment is fitted in such a way that there is no vibration during operation, and it is no heavier than the part of the combine which it replaces.

For grass, lucerne, etc., a special cutter bar, 8 ft. 6 in. long, is used. The forage cut by the cutter bar is transported by the existing conveyor into the ' Robust,' where it is chopped to the required fineness. From there the material is transported to the blower and elevated into a lorry or trailer. The Massey-Harris 726, equipped with the Mitchell Colman 95 attachment, has an output of 20 to 25 tons per hour.

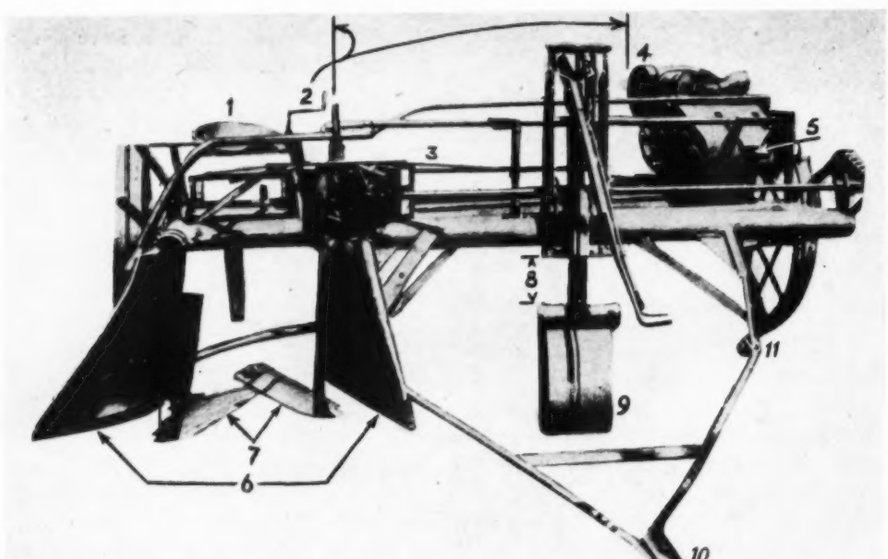
In addition to grass and lucerne, the forage harvester will handle material such as sugar beet leaf, potato haulm, etc., as well as kale (see illustration). The cutter bar can easily be removed and a standard pick-up reel put in its place in order that cut forage can be picked up and chopped to the required fineness for drying.

Another job for which it is suitable is chopping and distributing straw prior to its being ploughed in.

This machine won joint first prize at the forage harvester trials arranged by the Royal Agricultural Society of England, which were held last autumn.

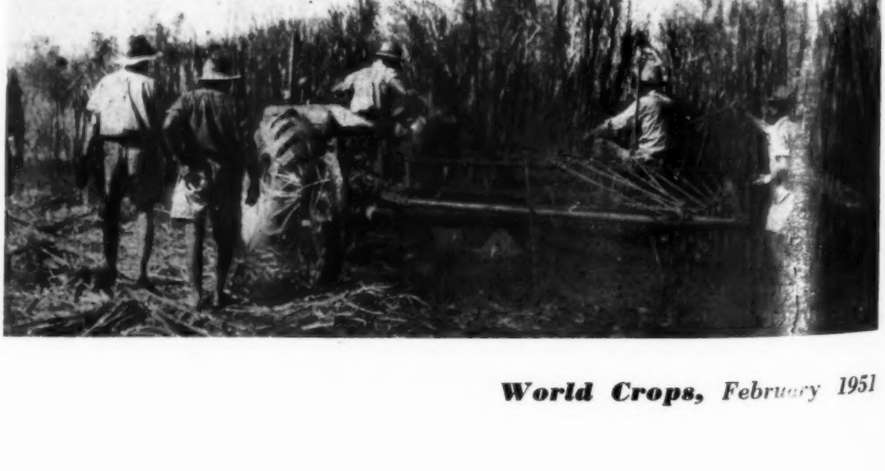
Australia has Four Mechanical Cane Harvesters

In our issue for August 1950 there appeared an illustration of a mechanical sugar cane harvester in operation in Queensland. This picture aroused interest in a number of quarters, and in response to enquiries we have collected some additional information about this and similar machines, which we reproduce below. In doing so we acknowledge our indebtedness to material recently published in the journal 'Australia,' and information kindly supplied by correspondents in the sub-continent.



(*Above*) **Kinnear Cane Harvesting Machine. Width of machine from skid-rim to skid-rim 10 ft. 9½ in. Total weight 18 cwt. 1. Operator's seat. 2. This handle moves topping device to any position between arrows above, to allow topping at correct height. 3. Rotary feeder arms. 4. Six-bladed independently powered topping device, 3 h.p. kerosene engine. 5. Topping knives. 6. Throat. 7. Fixed blades, adjustable horizontally. 8. Adjustment for ground cutting level. 9. Castor wheel regulating ground cutting. 10. Tractor drawn single-pin hitch. 11. Hinged hitch takes weight off tractor. The photographs of this machine were supplied to us by Mr. J. D. Kinnear of Sarina, North Queensland who constructed the prototype on his own farm during the war years**

(*Below*) **The Kinnear harvester in operation— somewhat obscured by dust and onlookers**



THE mechanical harvesting of sugar cane has for long exercised the ingenuity of engineers. In Queensland, Australia, the problem has assumed particular urgency during the last few years because of growing labour shortages. Moreover, Queensland is the only sugar-growing country where the cane crop is handled exclusively by European labour paid at standard labour rates and therefore all processes which can economise labour are of necessity important.

Today, no less than four types of mechanical harvester are being used. They are all of Australian design, and all are reported to be giving successful results—so much so that many experts consider that most of the problems of mechanical cane harvesting have been successfully solved.

The four machines are respectively known as the Kinnear, the Toft, the Moloney, and the Fairymead. Of these, the Kinnear is the most recent and is highly regarded by experts.

Some details of each are given below.

The Kinnear harvester

This is a separate machine which is hauled by any standard type of tractor. It cuts, tops and bundles the cane. As there are only three moving parts, wear and depreciation are reduced to a minimum. The machine is mounted on three wheels and is 10 ft. wide by 6 ft. long. It operates on the left-hand side of a field of cane, the tractor running just outside the first row. The cane is cut at ground level by two shear knives mounted on steel posts welded to the frame, and can be

A section of a harvested field as left by the Kinnear machine. The crop yielded 64 tons per acre

adjusted to suit the type of ground. The canes are guided into the machine by a multi-armed spider and topped by double-bladed topping knives, which can be adjusted to suit the length of the stems. The topped cane then falls to the ground where it is bundled by a series of tines which can be tripped when the bundles are sufficiently large. The topping knives are operated by a separate 3 h.p. engine mounted on the machine. The advantages of the Kinnear harvester are its simple construction and moderate price. Its operation requires two men, one on the tractor and the other on the harvester.

The Toft harvester

This machine, unlike the Kinnear, is self-propelled. It cuts, elevates, tops and bundles the cane. It is about 14 ft. long and 9 ft. wide, with a 4-ft. extension to carry the topping mechanism and is mounted on three wheels, two at the rear and one at the front, the front wheel being set to the left of the centre and providing the means of steering the machine from a driving platform.

The cutting mechanism is carried by an arm extending from the framework to the right front of the machine and carried by a castor wheel.

The Fairymead harvester

This is a two-row harvester and is also self-propelled, built onto a wheel-type Farmall model H tractor. It cuts and tops the cane, the topping being performed by two series of vertically spaced rotating and vertically spaced fixed blades. It operates simultaneously on two rows of cane and requires two men for its operation.

The Moloney harvester

This machine is stated to have given good results, but details of its construction are not yet available. It is a separate machine, travelling parallel to the tractor, by which it is drawn. It is stated to be able to handle about an acre of cane, bearing 30 tons, in one working hour, requiring two men to operate it.

New cane-loading device

The general practice in Queensland is to load canes by hand into cane trucks on a movable 2-ft. tramway, although the use of mechanical grab loaders of the type employed in other cane-growing countries has made some extensions and actually three Australian manufactured types are in operation; these are the Fairymead, the Toft and the Fowler.

A new development is a cane-loading device invented by Mr. D. Tracey, of Mackay, Queensland, designed for estates which load cane on to motor wagons and not on to tramway trucks. It consists of a device operated by driving the rear wheels of the truck on to two sets of rollers which operate the joisting tackle. It is stated that with it the load can be lifted to the desired height in ten seconds.

From these notes it is evident that mechanical handling of cane is making rapid progress in Queensland. It is worth recording, however, that it is the practice there to burn off cane straw before reaping the crop, which no doubt facilitates its mechanical handling.

Cubed Concentrates

Templewood Engineering Co. have designed a provender press for the production of dairy cubes, stock cubes and poultry pellets from dried grass or cereal meals.

The machine is hopper fed and an internal mixer is fitted for the adjustment of moisture content of the meal before cubing.

Meal is fed into a hopper which is equipped with an agitator and from it the meal is withdrawn by a ratchet-driven worm conveyor, the travel of which is controllable by a calibrated lever on the side of the machine. Water from a constant head tank fitted with a calibrated flow meter is mixed with the meal before it passes from the worm conveyor to the mixing chamber in which meal and water are combined to give a slightly damp powder. From the mixing chamber, the meal is passed to the vertical cubing chamber where further stirring takes place and the meal is then pressed downwards by a slight screw action into two annular crescent-shaped spaces between the stationary die-head and a revolving two-lobed cam. The die-head has a number of radial openings formed by slightly tapered tubes screwed into it and as the cam revolves, the meal in the crescent-shaped spaces is forced by wedge action into the holes in the die plate.

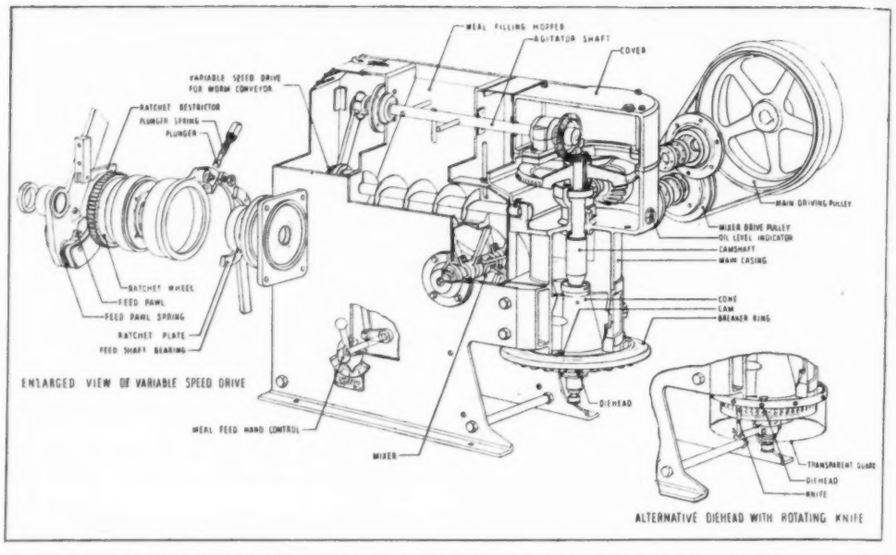
Considerable pressure is set up and some heat generated, and under these conditions the material binds together, issuing from the end of each tube as a cylindrical rod.

Mounted on the outside of the die-head is a removable metal ring so shaped as to interfere with the free egress of the compressed material after it has projected a fixed distance from the die. This causes the rod of material to be broken into fixed lengths of about 1 in., forming cubes.

The model described above is capable of producing about 5 cwt. per hour of 7/16 in. diam. dried grass cubes for a power consumption of approximately 15 h.p. The latest 'Roller Cam' model is capable of producing up to 12 cwt. per hour of 7/16 in. cubes. Whilst this output cannot be guaranteed on all meals the output on cereal meals is considerably higher, since output depends on the density as well as the quality of the meal. The 'Roller Cam' model is generally similar to the fixed cam model but incorporates a larger die-ring and long-wearing adjustable roller cams mounted on a modified feed cone and shaft. The feeding capacity has been increased to suit the higher output and the machine also runs slightly faster. (A sectional drawing of this machine is shown overleaf.)

R. O. Whyte to represent FAO

From March 1951 onwards for some months Dr. R. O. Whyte, ex-Director of the Commonwealth Bureau of Pastures and Field Crops, will act as the representative of FAO (Food and Agriculture Organisation of the United Nations) in an OEEC team which is to survey the grazing and fodder resources of certain Mediterranean countries in which the provision of animal fodder has become an important agricultural problem, with a direct bearing on the optimal conservation of vegetation, soil and water in the characteristic Mediterranean environment. Dr. Whyte has already had some experience of the problem in its more extreme form, having surveyed the fodder resources of Cyprus and Palestine in the winter of 1945-46.



Sectional drawing of the Templewood provender press (see previous page)

CORRESPONDENCE

Desert Locust Control in India and Adjoining Countries

TO THE EDITOR,
Dear Sir,

In WORLD CROPS, Vol. 2, No. 11, Dr. B. P. Uvarov made some observations on the control of the desert locust. These mainly focused attention on recent efforts in East Africa and western Arabia. There is, however, much need to complete the picture of the work against this notorious insect, of which extensive outbreak areas exist in India and adjoining countries.

The problem is admittedly an old one and in the last twenty years some notable attempts at its solution by several countries have been made. As a result, the requisite technical knowledge is available to deal with outbreaks fairly effectively. When and how our scientific and organisational efforts will reach a point at which fear of a locust plague will become a thing of the past is difficult to say, but our knowledge and experience in India encourages us to believe this ideal is attainable. If, however, the solution of the desert locust problem means that an end is to be put to the origin of swarms by changing the ecological condition of the outbreak centres, as Dr. Uvarov advocates, I fear that the solution may not be in sight for a long time. For these reasons the investigations and organised efforts to control the pest in India deserve to be better known than they appear to be to the readers of WORLD CROPS.

Following widespread locust breeding in India (undivided) during 1926-31, the Indian Council of Agricultural Research established in 1931 two organisations for laboratory and field research on the desert locust with headquarters at Lyallpur and Karachi (first at Quetta). The work of these threw extremely valuable light on locust biology, ecology, migrations and the causes for the rise of locust populations and the formation of incipient swarms. The results were published in scientific journals like the *Bull. Ent. Res.*, *Ind. Jl. Agric. Science*, etc. The two organisations were wound up in 1939 when the Government of India established a permanent Locust Warning Organisation, of which the chief functions were to watch the rise and fall of locust populations in their permanent breeding grounds, to give prompt warning of their entering the gregarious phase and to take measures for the control of incipient swarming. During a locust outbreak the organisation was expanded to cope with the increased scientific work. It endeavoured to collect, collate and disseminate information about breeding and swarm movements not only in India but also in other countries in the belt of the desert locust.

In 1940 the locust cycle began which lasted in India till 1946. The Locust Warning Organisation was expanded to four or five times its original strength and for the control of breeding in its desert homes of the locust a Control Wing was added to the organisation. Thus, control in all States containing outbreak areas was co-ordinated under a unified administration. The Central administration also exercised supervision over control operations in the non-desert areas where local authorities were responsible for the actual work. Thus the Government of India and those of the provinces and States concerned made a combined effort for the first time in history to fight the locust. During 1940-46 India was invaded on a large scale every year by swarms coming from the west. Compared to the magnitude of the menace, the damage to crops was comparatively very small, a result attributed by well-informed authorities to the co-ordinated anti-locust measures in India. Indeed, it was the first demonstration of how concerted and scientifically planned action can prevent the origin of appreciable numbers of swarms and avoid extensive damage to crops.

Even as early as the autumn of 1942 the U.K. representative at the International Anti-Locust Conference held at Tehran, considered that the immense work carried out in India during the summer of 1942 would probably break the backbone of the locust cycle. Again in 1943—one of the peak years of the outbreak in India—the International Anti-Locust Conference held at Karachi, expressed the opinion that the work in the previous summer (1943) had greatly reduced the chance of the westward migrations of swarms, usual at that time of the year. Subsequent events showed how well founded were these expectations, and during 1944 and 1945 no swarms crossed the western borders of India into Iran and Arabia.

India, however, did not confine her efforts to her own borders. She was the first country to send a locust mission to south-western Iran in the spring of 1942; similar parties were responsible for much work in Oman and other areas in eastern

Arabia each year from 1943 to 1946. In addition, Indian troops, at the request of the British Locust Entomologist in the Middle East, assisted in control operations in southern Iran in 1943, and later, in 1944, at the request of the Iranian Government, the Government of India assumed responsibility for locust control in Iranian Mekran.

Fortunately, at the time of the partition of India in 1947, the previous locust cycle was over. The permanent Locust Warning Organisation was then split into two—the Pakistani and Indian Organisations—but these, however, continued to work in close collaboration. Furthermore, since 1947 an Indo-Iranian Pakistan Anti-Locust Convention has been in force under which the member countries hold discussions during the locust season and formal conferences are convened at least once a year, to which other countries are also invited.

During the present locust cycle extensive control operations have been carried out in India, Pakistan and Iran, while these countries also assisted in anti-locust operations in Oman last spring. At the International Anti-Locust Conference, held recently at New Delhi, it transpired that in view of the situation in the area in the charge of Desert Locust Survey and Control (U.K.) plans for operations on a still larger scale had already been completed or were under way in India, Pakistan and Iran. It also appeared that Iraq and Afghanistan were also alive to the danger and were not without their own plans for control. In view of these facts Dr. Uvarov's observation that ' the coming Desert Locust plague may provide a salutary lesson to the few countries which prefer to keep aloof, hoping that efforts of others may save them trouble and expense ' cannot apply to the countries in the eastern region.

The writer feels that considerable fundamental work, *e.g.* mapping outbreak areas, etc., has yet to be carried out in certain countries in Arabia and Central and West Africa, and that in several tracts permanent survey organisations will have to be set up before it is possible to forecast the origin and movements of swarms in all countries affected by the desert locust.

It hardly needs stressing that control of the desert locust must be based on international collaboration among all countries affected and in any overall appraisement of the locust situation, work in all countries should be kept in view.

Yours faithfully,

HEM SINGH PRUTHI,
Director, Locust Control, and Plant Protection Adviser to the Government of India.

New Delhi, December 11, 1950.

The Decline of the Mulga Tree in New South Wales

Erosion-minded graziers in western New South Wales are worried because the mulga trees on their extensive sheep and cattle runs are dying out.

The mulga is an acacia (*Acacia anusa*); it is not an impressive tree and lacks the beauty of many of the acacias of the higher rainfall areas, rarely growing more than 15 ft. high and nondescript in colour and shape. It is, however, well adapted to an exacting environment, is highly resistant to drought and flourishes over vast areas where at times nothing else but the hardy spinifex or saltbush can live.

Erosion safeguard

For this reason the preservation of the mulga tree on these lands is important. Without this aid to bind the dry soils, wind erosion would play havoc with the rolling inland plains which are marginal for cattle and sheep; if the mulga died the stock also would have to go, and production from the marginal lands, though necessarily based on the extensive grazing of large holdings, is well worth while.

The leaves of the tree make good feed for stock and in a hard season when other pastures fail, the branches are cut to feed cattle and help to carry them through until the rains come and grass grows again.

The reasons for the present sudden decline in mulga growth are still something of a mystery. The tree is indigenous to the region and has probably been there for many thousands of years.

Cause of decline

Research officers of the New South Wales Conservation Service who were called in to ascertain the cause of the decline and, if possible, to find a remedy, carried out an extensive survey which showed that in many districts over 90% of the mulga are dying. Other trees in the same districts were, however, not affected and accordingly it does not seem that seasonal conditions can be blamed.

Parasitic mistletoe was found to be attacking some of the trees and termites and scarab beetles were damaging the roots of others, but the research men did not consider that either of these factors was of great significance. Their tentative conclusion was that the mulga trees are dying of old age and that the number of trees is dwindling because there is a dearth of young trees growing up to take their place. This they attribute to the intrusion of rabbits and the grazing of sheep. Mature mulga trees are normally too high for sheep or rabbits to reach the leaves, but both can and obviously do eat off the young seedling plants. This has apparently been going on for years, preventing normal natural regeneration, until at the present time existing stands consist almost entirely of old trees whose days are numbered; eventually none may be left unless the rabbits are destroyed and sheep removed. In the latter event lands would revert to their true role of a lightly stocked cattle region, with the mulga as a margin of survival for the cattle when the season is dry.

Over-exploitation dangers

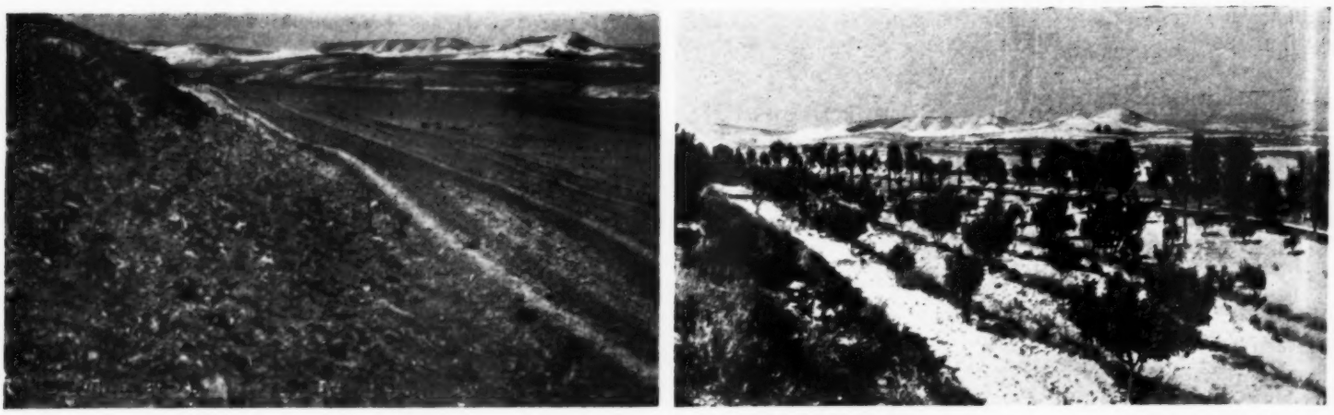
This survey has sharply emphasised that marginal lands cannot be over-exploited with impunity. In these days of world food shortages it is easy to think in terms of vigorous forcing of production from the land, of heavier grazing and of more intensive cultivation. It sounds simple enough to produce more meat by stocking pastures with bigger flocks and herds, and by extending grazing into the marginal areas.

Restraint needed

' Fill up the open spaces,' many people say, ' and there will be plenty for a hungry world to eat.' But in the west of New South Wales, where there are plenty of open spaces, and the fences are miles apart, the mulga is teaching the graziers greater wisdom. Where rainfall is plentiful, or where irrigation and the use of fertilisers can restore to the land the fertility removed in production, intensive grazing or cultivation may be sustained, but in marginal regions the limitations of nature must be accepted and the land exploited with proper restraint.

Gardens Guild to Visit Holland

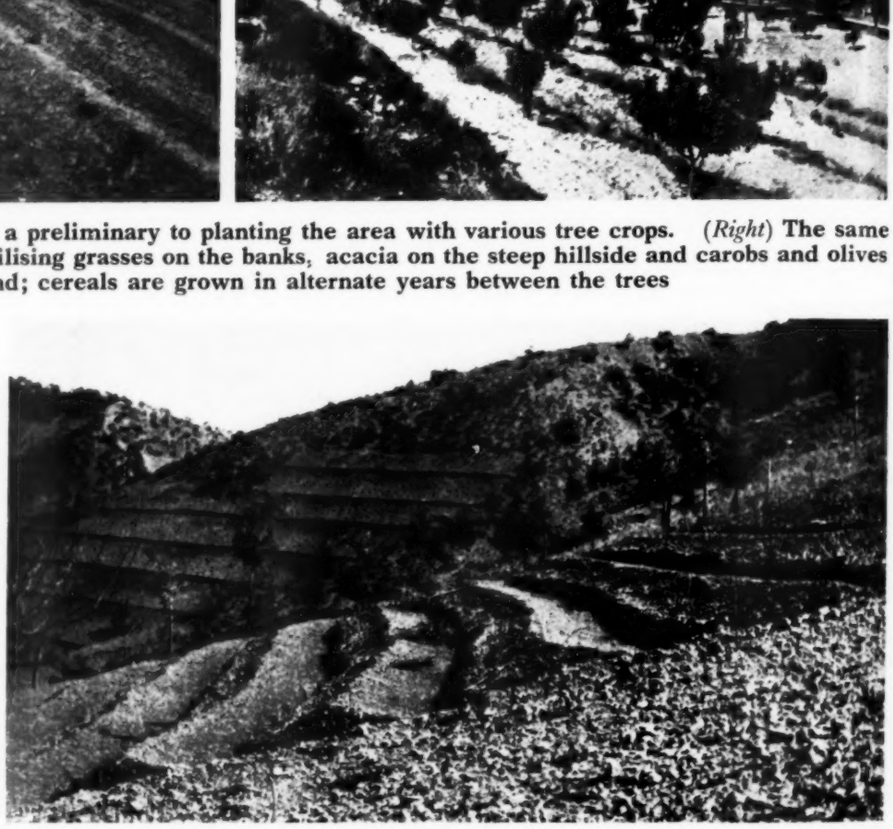
The National Gardens Guild is now making arrangements for its third post-war visit to Holland which will be from April 30 to May 9 this year. At this time the Dutch bulb fields should be at their best. The tour will include visits to Arnhem and Amsterdam—at the latter there will be a civic reception. Further details about the tour will be sent on application to the Secretary of the National Gardens Guild, 152 Edgwarebury Lane, Edgware, Middlesex, England.



(*Left*) **Contour banks made by hand as a preliminary to planting the area with various tree crops.** (*Right*) **The same area ten years later, planted with stabilising grasses on the banks, acacia on the steep hillside and carobs and olives on the lower ground; cereals are grown in alternate years between the trees**

Conservation in Cyprus

Much of the land in Cyprus is stony, and under these conditions it has long been the practice on steeply sloping lands to use the stones to build up bench terraces, or on gently sloping lands to form contoured stone bunds. On lands free from stones other measures have to be adopted, and here it is the usual practice on steep lands to make earth terraces, sloping slightly from front to back; the vertical face is protected by a vegetative cover, usually grass. These are sometimes termed *gradoni* terraces; this form of protection is widely practised in many other countries under similar conditions; for example, in Ceylon or Malaya in tea and rubber plantations, in many parts of the U.S.A. and in Southern Europe.



On steep land, where stone for terracing is not available, the construction of 'gradoni' terraces enables land to be used without causing erosion

Netherlands Soils' Fresh Water Shortage

The Dutch Horticultural Council recently arranged a conference to discuss the problem of shortages of fresh water for agriculture which has become urgent, particularly in the western parts of the Netherlands.

The meeting was primarily for agriculturists and horticulturists, but many interested individuals from the Departments of Buildings and Roads and from the Polder Boards also attended and participated in the discussions.

In opening the meeting, **Dr. G. de Bakker**, Inspector of Horticultural Research, pointed out that having won the battle of reclamation it now became necessary to begin the struggle for adequate supplies of fresh water for agriculture and horticulture. He emphasised the danger of fresh water shortage as a result of salting of cultivated lands, and pointed out that in future Dutch market gardeners would have to use fresh water very economically and pay greater attention to water control on cultivated lands.

Mr. van den Berg, Chief of the Scientific Staff of the Re-allotment Service for the Walcheren (Zeeland) peninsula, demonstrated by means of maps and charts how the Zeeland Islands were suffering increasingly from salting of their soils and emphasised how a solution of the problem necessitated close co-operation between research workers and practising agriculturists. The problem was especially urgent since only in a limited number of cases could raising the water level in polders give an effective solution.

Mr. Riemens, Horticultural Adviser for the South Holland Glasshouse District, indicated certain essential points in the economic management of fresh water supplies. He stressed the dangers that arose from the excessive drilling of wells and boreholes. This was going on in many agricultural and horticultural holdings. It led to the infiltration of sea water and could give rise to saline ooze. The use of manures containing salt was now prohibited in this district. The only available means of counteracting salting was flushing with fresh water and this demanded adequate supplies. In particular was the matter important in relation to greenhouse work.

Mr. F. de Gruyter, Chief Engineer of the Rhineland District, stressed the necessity of keeping continually replenished supplies of fresh water in storage basins and seeing that saline or salt contaminated drainage water is effectively removed. He concluded by presenting a series of definite recommendations calculated to ensure the efficient use of fresh water.

WORLD CROP REPORTS

Poor Australian wheat prospects

Wheat prospects over Australia's licensed 12 million-odd acres are far from good this year. On December 1 the Australian Wheat Board chairman, Mr. J. S. Teasdale, after announcing that the wheat industry has suffered a major disaster through almost continuous rain in Queensland and New South Wales during the last two months, stated: 'The prospective export of FAQ wheat has dropped from 125 million bushels to approximately 85 million —just about the amount pledged by Australia under the International Wheat agreement for the year.' He said that instead of the 13 million bushels of millable FAQ wheat expected from Queensland, estimated receival was 6 million bushels FAQ and 3 million bushels undergrade. Instead of 59-60 million bushels of FAQ wheat from New South Wales the expected yield was 15 million bushels FAQ and 25 million bushels undergrade. Mr. Teasdale added that crops in Victoria, South Australia and Western Australia, however, should be above average.

Western Australia's wheat harvest for 1950-51 is expected to be the second highest on record, and the highest since bulk handling was introduced in 1934. It will total more than 40 million bushels, as against the previous year's 34,750,000 bushels. (All-time record was 49,500,000 bushels, established 20 years ago.)

Official estimates put Australia's total 1950-51 crop at about 170 million bushels. Last year it was 218 million bushels.

Separate pools would be established for wheat weighing less than 54 lb. a bushel. Some of it would go on to the local market at a discount, while India and Oriental countries would probably buy the balance, he said.

Pending clarification of the stock position, the Board has suspended further offering of large quantities for the overseas markets, but trade in flour and smaller quantities of wheat to nearby countries is not affected.

Canada had $1,483m. crops

Canada's principal field crops, on the basis of a preliminary estimate, were worth 1,482,901,000 dollars last year compared with 1,544,014,000 dollars in 1949, a drop of about 4%, the Bureau of Statistics reports.

The 1950 gross dollar value of the crops, due for revision upward when anticipated participation payments are paid on western grains, was the fifth highest in history. It was exceeded only in 1919, 1947, 1948 and 1949.

The quality of frost-damaged western wheat and barley, the lower initial price for western wheat, and a lower average price for potatoes were factors mainly responsible for the decrease.

The wheat crop of 465,300,000 bushels —about 95,000,000 bushels greater than in 1949—was valued at 491,000,000 dollars compared with 566,114,000 dollars, a drop of 13%. The average farm value dropped from 1.54 dollars a bushel in 1949 to 1.06 dollars this year.

The oats crop of 255,000,000 bushels—65,000,000 bushels greater than in 1949—was valued at 265,776,000 dollars compared with 251,045,000 dollars. The barley crop of 171,000,000 bushels—50,000,000 greater than in 1949—was valued at 133,879,000 dollars compared with 157,124,000 dollars.

French colonial groundnuts

Groundnut crops in French overseas territories were estimated in private trade circles in Paris at 420,000 tons last year—roughly the same as the season before. This is still 10% less than normal but is better than first estimates indicated. The quality is not very good because shells are very thick.

Nicaraguan sesame

Nicaraguan farmers have renewed their interest in growing sesame seed. According to the Assistant Attache, American Embassy, Managua, about 25,900 acres have been planted to sesame this last season. This is an increase of 25% over the 1949-50 (revised) acreage.

It is difficult to forecast production accurately because of heavy rains in October, but 6,000 to 7,000 short tons may be expected.

WORLD CROPS

OUR NEXT ISSUE will include a detailed account of **mechanical land-clearing methods** employed by the Overseas Food Corporation in Tanganyika, an article on the **cultivation of linseed** and a description of the **coconut coir industry in Ceylon**—in addition to other main articles and regular features.

World 1950-51 tobacco forecast

The world's tobacco harvest during the 12 months, July 1950 to June 1951, is now forecast at 7,220 million lb. as compared with a revised estimate of 1949-50 production of 7,100 million lb. and the pre-war average, 1935-39, output of 6,597 million lb. The world crop is now forecast at approximately 2% above the revised 1949-50 output.

Moderate increases in production in a number of important tobacco-producing countries throughout the world account for the larger harvests forecast for 1950-51. A somewhat larger output of leaf tobacco is forecast for every major geographical area of the world, except North America where a slight decline is indicated. However, since this forecast includes production in the torrid and south temperate zones where 1950-51 harvests occur during the first half of 1951, world production may vary substantially from the above forecast.

The 1950-51 production of flue-cured leaf, the principal type entering world trade, will be larger than the 1949-50 harvest. Larger crops are expected in most major producing countries, including the United States, Southern Rhodesia, China, India and Japan. Increased world demand for this type of leaf has also encouraged an expansion in flue-cured production in numerous other countries throughout the world.

It is estimated that the 1950-51 harvest of Oriental or Turkish-type tobacco, another important type entering world trade, will be below the 1949-50 output. Moderate increases in production in Greece and certain minor producing countries are offset by declines in Turkey and the Balkan countries.

The world production of light air-cured types, including Burley, which represent an important portion of total production in many producing countries, is estimated to be about equal to the 1949-50 output. Declines in the production of these types in the United States are expected to be offset by moderate increases in a number of countries. The production of dark types, other than strictly cigar leaf, is expected to exceed the 1949-50 output. Cigar-leaf production will probably be about the same as in 1949-50.

Brazilian orange crop

According to the Ministry for Agriculture, the orange crop in the State of Sao Paulo for 1950 is estimated at 1,052,032,000 units, worth Cr.$102,051 million, this representing a decrease of 49,003,000 oranges when compared with 1949.

More S. African wheat

The 1950-51 wheat crop in the Union of South Africa is expected to be about 15% above the pre-war (1935-39) average and considerably above the small 1949-50 output. Unofficial sources forecast a crop of about 18.3 million bushels compared with the final official estimate of 15 million bushels a year ago. The gain over the pre-war production is attributed mainly to increased acreage.

Harvesting operations began in November and continued through early January. The November forecast of the wheat crop was about 10% less than earlier forecasts, which indicated a near-record crop in prospect. Deterioration resulted from frost in early October and some drought.

Wheat stocks on hand at the end of August 1950 were slightly larger than a year earlier and are considered sufficient to put the country in a relatively good supply position. Indigenous supplies and wheat on order would cover the country's requirements without further purchases through 1951, according to the manager of the Wheat Board. Purchases may be made this year, however, for use during the first half of 1952. The Union's annual quota under the International Wheat Agreement is about 11 million bushels. Purchases through mid-October accounted for 75% of that total for the 1950-51 year.

Storage facilities for grain have never been adequate and South Africa is now engaged in building a large horizontal storage building in the western Transvaal, which is expected to be completed early in 1952. This is a pilot storage plant, which if satisfactory may be used as a model for the expansion of storage facilities throughout the Union on a long-term basis.

Little information is available concerning the important maize crop, which is normally planted in October-January and harvested in April-May. Above-average autumn rainfall made soil conditions favourable for ploughing, and acreage is expected to be somewhat larger than plantings a year earlier. Some hybrid seed maize is available for distribution from experimental plantings, but the area planted to hybrid varieties will be relatively small.

S. African cotton renaissance

Attracted by rising cotton prices, many South African farmers are turning to cotton this year with high hopes of making money. Farmers are preparing to treble their planting this year and 25,000 bales will be picked—if the insects do not get them first. Last year only 6,000 bales were produced—pests got the rest. The price of cotton in South Africa has never been higher; it has risen from 4d. a pound for seed cotton to 10d. The demands of newly established textile industries are such that it may become one of the country's best paying crops and farmers are counting on this. The country requires 60,000 bales at the moment, more than double what farmers could supply with a record crop, and officials of the Department of Agriculture estimate that soon the textile industries will need 120,000 bales a year. Not since 1902, say the officials, have farmers taken such an interest in cotton. Then, as now, there was a world demand, and scores of farmers tried their luck with what they hoped would be a lucrative crop. Many lost everything through insect pests.

The bulk of the Union's supply of cotton today comes from Rhodesia, but manufacturers are worried about the rising cotton prices there. Rhodesian cotton recently rose 5d. a pound and South African cotton may be the industry's hope of cheap production in the future. It all depends upon whether the insects can be beaten.

Australian reports

Flax. A new variety of flax, Wada, bred by the Western Australian Department of Agriculture, may provide the best and most payable flax crop in that State, our Correspondent reports. The new flax is rust-free.

Pepper. 'High prices for imported pepper may lead to a new agricultural industry in Northern Queensland,' said Mr. Collins, Minister for Agriculture. 'Today pepper is selling at 3s. 1d. per oz. in Australia, and pepper plant trials are being carried out after a lapse of 35 years.' (Pepper vines were established at a Queensland experiment station many years ago but they died off when the station closed in 1915.)

Pakistan's exports to Austria

6,500 tons of jute, 10,000 tons of wheat, 2,200 tons of long staple and short staple cotton will be the main commodities to be exported from Pakistan to Austria according to the Trade Agreement, concluded by the official Trade Delegation from Pakistan in London.

Guts to the value of £75,000 and skins, including Dacca variety and kips of the value of £30,000, are two other commodities. Also 2,000 tons of cottonseed cake, 1,000 tons of fish bone meal, 600 tons of carpet wool, 500 tons of chromium ore, and 50 tons of tea. Miscellaneous items will cover another £10,000 of exports from Pakistan to Austria.

Greek fig crop

The 1950 Greek fig crop yielded 14,500 tons, of which 7,000 tons were exported to the U.S. and 2,000 to Germany. About 2,000 tons will be consumed locally, and efforts are being made to export the remaining stocks to the U.K., France, and Holland.

23 years of Australian rice production

In 1927, when Australia reaped her first commercial crop of rice off 157 acres, between 20,000 and 25,000 tons of this all-important cereal were being imported into the country annually.

Today, Australia has 36,533 acres under rice production—a harvest of 70,293 tons (1949-50). The greater part of the harvest is exported.

Large Nigerian cacao forecast

Nigeria's 1950-51 cacao production has been tentatively forecast at about 225 million lb. by the Nigerian Department of Marketing and Exports. This is roughly equal to the revised estimate of 228 million lb. for the 1949-50 crop, and not very much smaller than the record output of 242 million lb. in 1948-49.

The Nigerian Cocoa Marketing Board has released statistics of Nigeria's cacao exports during the 1949-50 season. Total exports amounted to 222 million lb., composed of 203 million lb. of main-crop cacao and 19 million of mid-crop. Practically 90% of these exports consisted of Grade I cacao, and only an insignificant amount of Grade III cacao was exported.

Replanting in areas attacked by swollen shoot disease is progressing satisfactorily. Some new planting is being undertaken, but the Nigerian Government is not encouraging expansion of cacao cultivation. There is a serious shortage of locally grown food crops in Nigeria with which cacao competes. In former times, cacao farmers grew most of what they ate. Now, with higher prices for cacao, they buy most of their food in the markets.

(*Foreign Crops and Markets.*)

West African oilseeds

Nuts and oilseeds to be imported from British West Africa in 1951 by the United Kingdom will cost from 25 to $33\frac{1}{3}\%$ more than in 1950, according to an agreement reached between the British Ministry of Food and representatives of producers in West Africa.

British West Africa normally exports each year 900,000 tons of groundnuts, sesame seed, palm kernels, palm oil, and cottonseed. This increase in price probably will necessitate the British Government's increasing its budget for the purchase of fats and oils by at least £12 million.